19

Vital Signs

LEARNING OBJECTIVES

Temperature

1. Define a vital sign.
2. Explain the reason for taking vital signs.
3. Explain how body temperature is maintained.
4. List examples of how heat is produced in the body.
5. List examples of how heat is lost from the body.
6. State the normal body temperature range and the average body temperature.
7. List and explain factors that can cause variation in the body temperature.
8. List and describe the three stages of a fever.
9. List the sites for taking body temperature, and explain why these sites are used.
10. List and describe the guidelines for using a tympanic membrane thermometer.

Pulse

1. Explain the mechanism of pulse.
2. List and explain the factors that affect the pulse rate.
3. Identify a specific use of each of the eight pulse sites.
4. State the normal range of pulse rate for each age group.
5. Explain the difference between pulse rhythm and pulse volume.

Respiration

1. Explain the purpose of respiration.
2. State what occurs during inhalation and exhalation.
3. State the normal respiratory rate for each age group.
4. List and explain the factors that affect the respiratory rate.
5. Explain the difference between the rhythm and depth of respiration.
6. Describe the character of each of the following abnormal breath sounds: crackles, rhonchi, wheezes, and pleural friction rub.

Pulse Oximetry

1. Explain the purpose of pulse oximetry.
2. State the normal oxygen saturation level of a healthy individual.
3. List and describe the function of the controls, indicators, and displays on a pulse oximeter.
4. Describe the difference between a reusable and a disposable oximeter probe.
5. List and describe factors that may interfere with an accurate pulse oximetry reading.

Blood Pressure

1. Define blood pressure.
2. State the normal range of blood pressure for an adult.
3. List and describe factors that affect the blood pressure.
4. Identify the different parts of a stethoscope and a sphygmomanometer.
5. Identify the Korotkoff sounds.
6. Explain how to prevent errors in blood pressure measurement.

PROCEDURES

- Measure oral body temperature.
- Measure axillary body temperature.
- Measure rectal body temperature.
- Measure aural body temperature.
- Measure temporal artery body temperature.
- Measure radial pulse.
- Measure apical pulse.
- Measure respiration.
- Perform pulse oximetry.
- Measure blood pressure.
- Determine systolic pressure by palpation.

CHAPTER OUTLINE

Introduction to Vital Signs

Temperature
- Regulation of Body Temperature
- Body Temperature Range
- Assessment of Body Temperature

Pulse
- Mechanism of the Pulse
- Assessment of Pulse

Respiration
- Mechanism of Respiration
- Assessment of Respiration

Pulse Oximetry
- Assessment of Oxygen Saturation

Blood Pressure
- Mechanism of Blood Pressure
- Assessment of Blood Pressure

CAAHEP COMPETENCIES

Clinical Competencies

Patient Care
- Obtain vital signs.
- Prepare and maintain examination and treatment areas.

General Competencies

Professional Communications
- Recognize and respond to verbal communications.
- Recognize and respond to nonverbal communications.

Patient Instruction
- Provide instruction for health maintenance and disease prevention.

Operational Functions
- Perform routine maintenance of administrative and clinical equipment.

ABHES COMPETENCIES

Communication
- Recognize and respond to verbal and nonverbal communication.
- Principles of verbal and nonverbal communication.

Clinical Duties
- Take vital signs.

Office Management
- Operate and maintain facilities and perform routine maintenance of administrative and clinical equipment safely.

Instruction
- Teach patients methods of health promotion and disease prevention.

KEY TERMS

adventitious (ad-ven-TISH-us) sounds
afebrile (uh-FEB-ril)
alveolus (al-VEE-uh-lus)
antecubital (AN-tih-CYOO-bi-tul) space
antipyretic (AN-tih-pye-REH-tik)
aorta (ay-OR-tuh)
apnea (AP-nee-uh)
axilla (aks-ILL-uh)
bounding pulse
bradycardia (BRAY-dee-CAR-dee-uh)
bradypnea (BRAY-dip-NEE-uh)
Celsius (SELL-see-us) scale
conduction (kon-DUK-shun)
convection (kon-VEK-shun)
crisis
cyanosis (sye-an-OH-sus)
diastole (dye-AS-toe-lee)
diastolic (DYE-uh-STOL-ik) pressure
dyspnea (DISP-nee-uh)
dysrhythmia (dis-RITH-mee-uh)
eupnea (YOOP-nee-uh)
exhalation (EKS-hal-AY-shun)
Fahrenheit (FAIR-en-hite) scale
febrile (FEH-bril)
fever
frenulum linguae (FREN-yoo-lum LIN-gway)
hyperpnea (HYE-perp-NEE-uh)
hyperpyrexia (HYE-per-pye-REK-see-uh)
hypertension (HYE-per-TEN-shun)
hyperventilation (HYE-per-ven-til-AY-shun)
hypopnea (hye-POP-nee-uh)
hypotension (HYE-poe-TEN-shun)
hypothermia (HYE-poe-THER-mee-uh)
hypoxemia (hye-pok-SEE-mee-uh)
hypoxia (hye-POKS-ee-uh)
inhalation (IN-hal-AY-shun)
intercostal (IN-ter-KOS-tul)
Korotkoff (kuh-ROT-kof) sounds
malaise (mal-AYZE)
manometer (man-OM-uh-ter)
meniscus (men-IS-kus)
orthopnea (orth-OP-nee-uh)
pulse oximeter
pulse oximetry
pulse pressure
pulse rhythm

KEY TERMS—cont'd

pulse volume
radiation (RAY-dee-AY-shun)
SaO_2
sphygmomanometer (SFIG-moe-man-OM-uh-ter)
SpO_2
stethoscope (STETH-uh-skope)
systole (SIS-toe-lee)
systolic (sis-TOL-ik) pressure
tachycardia (TAK-ih-KAR-dee-uh)
tachypnea (TAK-ip-NEE-uh)
thready pulse

Introduction to Vital Signs

Vital signs are objective guideposts that provide data to determine a person's state of health. The vital signs include temperature, pulse, respiration (collectively called *TPR*), and blood pressure (BP). Another indicator of a patient's health status is pulse oximetry. Although some physicians order this measurement routinely on all patients as part of the patient workup, most physicians only order this vital sign when the patient complains of respiratory problems (e.g., shortness of breath).

The normal ranges of the vital signs are finely adjusted, and any deviation from normal may indicate disease. During the course of an illness, variations in the vital signs may occur. The medical assistant should be alert to any significant changes and report them to the physician because they indicate a change in the patient's condition. When patients visit the medical office, vital signs are routinely checked to establish each patient's usual state of health and establish baseline measurements against which future measurements can be compared. The medical assistant should have a thorough knowledge of the vital signs and attain proficiency in taking them to ensure accurate findings.

General guidelines that the medical assistant should follow when measuring the vital signs are as follows:

1. Be familiar with the normal ranges for all vital signs. Keep in mind that normal ranges vary based on the different age groups (infant, child, adult, elder).
2. Make sure that all equipment for measuring vital signs is in proper working condition to ensure accurate findings.
3. Eliminate or minimize factors that affect the vital signs, such as exercise, food and beverage consumption, and emotional states.
4. Use an organized approach when measuring the vital signs. If all of the vital signs are ordered, they are usually measured starting with temperature, followed by pulse, respiration, blood pressure, and pulse oximetry.

TEMPERATURE

Regulation of Body Temperature

Body temperature is maintained within a fairly constant range by the hypothalamus, which is located in the brain. The hypothalamus functions as the body's thermostat. It normally allows the body temperature to vary only about 1° to 2° Fahrenheit (F) throughout the day.

Body temperature is maintained through a balance of the heat produced in the body and the heat lost from the body (Figure 19-1). A constant temperature range must be maintained for the body to function properly. When minor changes in the temperature of the body occur, the hypothalamus senses this and makes adjustments as needed to ensure that the body temperature stays within a normal and safe range. If an individual is playing tennis on a hot day, the body's heat-cooling mechanism is activated to remove excess heat from the body through perspiration.

Heat Production

Most of the heat produced in the body is through voluntary and involuntary muscle contractions. Voluntary muscle contractions involve the muscles over which a person has control (e.g., the moving of legs or arms). Involuntary muscle contractions involve the muscles over which a person has no control; examples are physiologic processes such as digestion, the beating of the heart, and shivering.

Body heat is also produced by cell metabolism. Heat is produced when nutrients are broken down in the cells. Fever and strong emotional states also can increase heat production in the body.

Heat Loss

Heat is lost from the body through the urine and feces and in water vapor from the lungs. Perspiration also contributes to heat loss. Perspiration is the excretion of moisture through the pores of the skin. When the moisture evaporates, heat is released and the body is cooled.

Radiation, conduction, and convection all cause loss of heat from the body. **Radiation** is the transfer of heat in the

form of waves; body heat is continually radiating into cooler surroundings. **Conduction** is the transfer of heat from one object to another by direct contact; heat can be transferred by conduction from the body to a cooler object it touches. **Convection** is the transfer of heat through air currents; cool air currents can cause the body to lose heat. These processes are illustrated in Figure 19-2.

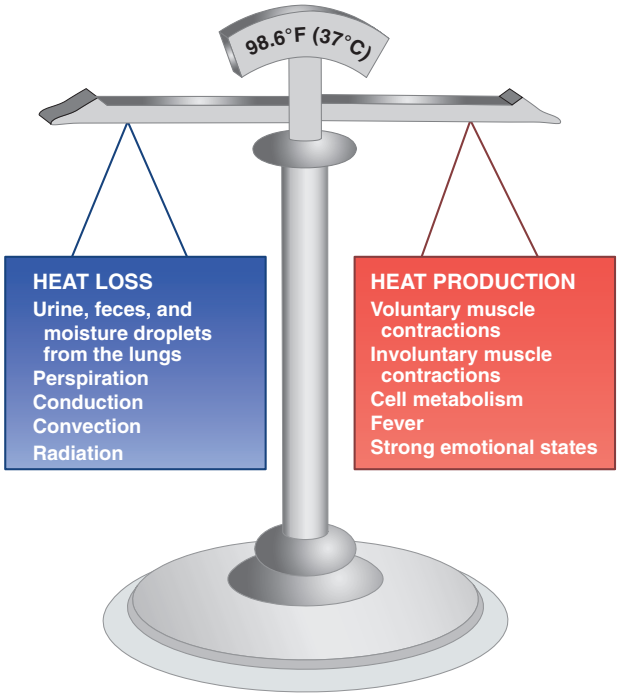


Figure 19-1. Body temperature represents a balance between the heat produced in the body and the heat lost from the body. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Body Temperature Range

The purpose of measuring body temperature is to establish the patient's baseline temperature and to monitor an abnormally high or low body temperature. The normal body temperature range is 97°F to 99°F (36.1°C to 37.2°C), the average temperature being 98.6°F (37°C). Body temperature is usually recorded using the Fahrenheit system of measurement. Table 19-1 lists comparable **Fahrenheit** and **Celsius** temperatures and explains how to convert temperatures from one scale to the other.

Alterations in Body Temperature

A body temperature greater than 100.4°F (38°C) indicates a **fever,** or *pyrexia.* If the body temperature falls between 99°F (37.2°C) and 100.4°F (38°C), it is termed a *low-grade fever.* When an individual has a fever, the heat that the body is producing is greater than the heat the body is losing. A temperature reading greater than 105.8°F (41°C) is known as **hyperpyrexia.** Hyperpyrexia is a serious condition, and a temperature greater than 109.4°F (43°C) is generally fatal.

A body temperature less than 97°F (36.1°C) is classified as subnormal, or **hypothermia.** This means that the heat the body is losing is greater than the heat it is producing. A person usually cannot survive with a temperature less than 93.2°F (34°C). Terms used to describe alterations in body temperature are illustrated in Figure 19-3.

Variations in Body Temperature

During the day-to-day activities of an individual, normal fluctuations occur in the body temperature. The body temperature rarely stays the same throughout the course of a day. The medical assistant should take the following

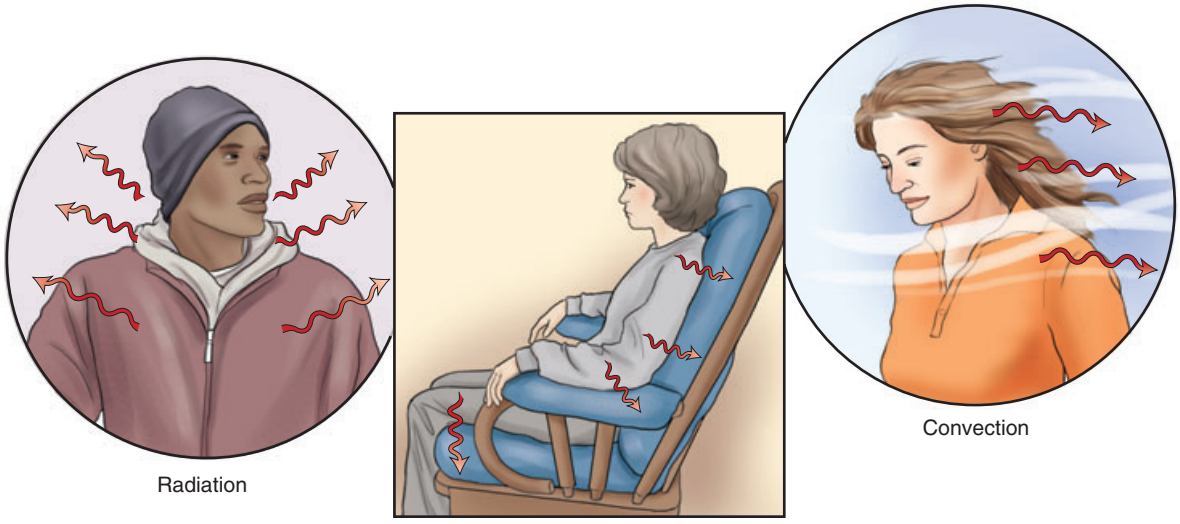


Figure 19-2. Heat loss from the body. With radiation, the body gives off heat in the form of waves to the cooler outside air. With conduction, the chair becomes warm as heat is transferred from the individual to the chair. With convection, air currents move heat away from the body. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Table 19-1 Equivalent Fahrenheit and Celsius Temperatures

Fahrenheit	Celsius
93.2	34
95	35
96.8	36
97.7	36.5
98.6	37
99.5	37.5
100.4	38
101.3	38.5
102.2	39
104	40
105.8	41
107.6	42
109.4	43
111.2	44

Temperature Conversion

1. Celsius to Fahrenheit: To convert Celsius to Fahrenheit, multiply by 9/5 and add 32:

$$°F = (°C \times 9/5) + 32$$

2. Fahrenheit to Celsius: To convert Fahrenheit to Celsius, subtract 32 and multiply by 5/9:

$$°C \times (°F - 32) \times 5/9$$

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.

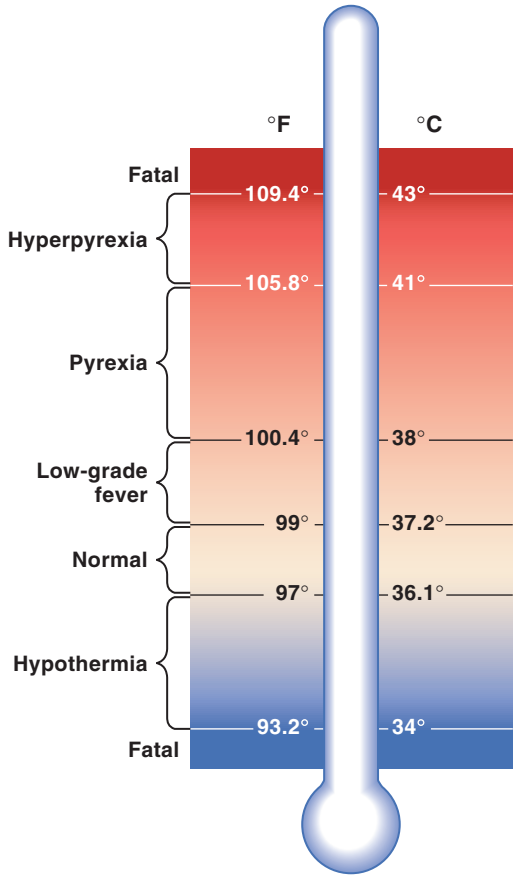


Figure 19-3. Terms that describe alterations in body temperature (adult oral temperature). (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

points into consideration when evaluating a patient's temperature.

1. **Age.** Infants and young children normally have a higher body temperature than adults because their thermoregulatory system is not yet fully established. Elderly individuals usually have a lower body temperature owing to factors such as loss of subcutaneous fat, lack of exercise, and loss of thermoregulatory control. Table 19-2 shows the normal ranges of body temperature according to age group.
2. **Diurnal variations.** During sleep, body metabolism slows down, as do muscle contractions. The body's temperature is lowest in the morning before metabolism and muscle contractions begin increasing.
3. **Emotional states.** Strong emotions, such as crying and extreme anger, can increase the body temperature. This is important to consider when working with young children, who frequently cry during examination procedures or when they are ill.
4. **Environment.** Cold weather tends to decrease the body temperature, whereas hot weather increases it.
5. **Exercise.** Vigorous physical exercise causes an increase in voluntary muscle contractions, which elevates the body temperature.
6. **Patient's normal body temperature.** Some patients normally run a low or high temperature. The medical assistant should review the patient's past vital sign recordings.
7. **Pregnancy.** Cell metabolism increases during pregnancy, which elevates body temperature.

Table 19-2 Variations in Body Temperature by Age

Age	Site	Average Temperature	
Newborn	Axillary	97-100°F	36.1-37.8°C
1 yr	Oral	99.7°F	37.6°C
5 yr	Oral	98.6°F	37°C
Adult	Oral	98.6°F	37°C
	Rectal	99.6°F	37.5°C
	Axillary	97.6°F	36.4°C
	Aural	98.6°F	37°C
Elderly (older than 70 yr)	Oral	96.8°F	36°C

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.

Fever

Fever, or pyrexia, denotes that a patient's temperature has increased to greater than 100.4°F (38°C). An individual who has a fever is said to be **febrile;** one who does not have a fever is **afebrile.**

Fever is a common symptom of illness, particularly inflammation and infection. When there is an infection in the body, the invading pathogen functions as a *pyrogen,* which is any substance that produces fever. Pyrogens reset the hypothalamus, causing the body temperature to increase above normal. Fever is not an illness itself, but rather a sign that the body may have an infection. Most fevers are self-limiting; that is, the body temperature returns to normal after the disease process.

Stages of a Fever

A fever can be divided into the following three stages:

1. The *onset* is when the temperature first begins to increase. The increase may be slow or sudden, the patient often experiences coldness and chills, and the pulse and respiratory rate increase.
2. During the *course of a fever,* the temperature rises and falls in one of the following three fever patterns: continuous, intermittent, or remittent. Fever patterns are described and illustrated in Table 19-3. During this stage, the patient has an increased pulse and respiratory rate and feels warm to the touch. The patient also may experience one or more of the following: flushed appearance, increased thirst, loss of appetite, headache, and malaise. **Malaise** refers to a vague sense of body discomfort, weakness, and fatigue.
3. During the *subsiding stage,* the temperature returns to normal. It can return to normal gradually or suddenly (known as a **crisis**). As the body temperature is returning to normal, the patient usually perspires and may become dehydrated.

Assessment of Body Temperature

Assessment Sites

Five sites are available for measuring body temperature: mouth, **axilla,** rectum, ear, and forehead. The locations in

Highlight on Fever

Although most fevers indicate an infection, not all do. Noninfectious causes of fever include heatstroke, drug hypersensitivity, neoplasms, and central nervous system damage.

A fever is usually not harmful if it remains less than 102°F (38.9°C). Research suggests that fever may serve as a defense mechanism to destroy pathogens that are unable to survive above the normal body temperature range.

The level of the fever is not related to the seriousness of the infection. A patient with a temperature of 104°F (40°C) may not be any sicker than a patient with a temperature of 102°F (38.9°C).

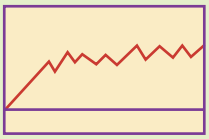
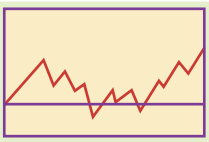
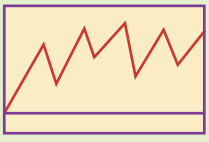
In children, fever often is one of the first signs of illness and has a tendency to become highly elevated. In contrast, in elderly patients, fever may be elevated only 1°F to 2°F above normal, even with a severe infection.

During a fever, the body's basal metabolism increases 7% for each degree of temperature elevation. Heart and respiratory rates also increase to meet this metabolic demand.

Chills during a fever result when the hypothalamus has been reset at a higher temperature. In an attempt to reach this temperature, involuntary muscle contractions (chills) occur, which produce heat, causing the temperature of the body to increase. After the higher temperature has been reached, the chills subside and the individual then feels warm.

Increased perspiration during a fever occurs when the hypothalamus has been reset at a lower temperature (e.g., after taking an **antipyretic** or after the cause of the fever has been removed). To cool the body and reach this lower temperature, the body perspires, often profusely; profuse perspiration is known as *diaphoresis.* ■

Table 19-3 Fever Patterns

Pattern	Description	Illustration
Continuous fever	Body temperature fluctuates minimally but always remains elevated *Occurs with:* Scarlet fever Pneumococcal pneumonia	
Intermittent fever	Body temperature alternately rises and falls and at times returns to normal or becomes subnormal *Occurs with:* Bacterial infections Viral infections	
Remittent fever	Wide range of temperature fluctuations occur, all of which are above normal *Occurs with:* Influenza Pneumonia Endocarditis	

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.

which temperatures are taken should have an abundant blood supply so that the temperature of the entire body is obtained, not the temperature of only a part of the body. In addition, the site must be as closed as possible to prevent air currents from interfering with the temperature reading. The site chosen for measuring a patient's temperature depends on the patient's age, condition, and state of consciousness; the type of thermometer available; and the medical office policy.

Oral Temperature

The oral method is a convenient and one of the most common means for measuring body temperature. When the medical assistant records a temperature, the physician assumes it has been taken through the oral route, unless it is otherwise noted. A rich blood supply is found under the tongue in the area on either side of the **frenulum linguae.** The thermometer should be placed in this area to receive the most accurate reading. The patient must keep the mouth closed during the procedure to provide a closed space for the thermometer.

Axillary Temperature

Axillary temperature is recommended as a site for measuring temperature in toddlers and preschoolers. The axillary site also should be used for mouth-breathing patients and for patients with oral inflammation or who have had oral surgery.

The temperature obtained through the axillary method measures approximately 1°F lower than the same person's temperature taken through the oral route (see Table 19-2). The medical assistant should make a notation to tell the physician that the temperature was taken through the axillary route.

Rectal Temperature

The rectal temperature provides an extremely accurate measurement of body temperature because few factors can alter the results. The rectum is highly vascular and, of the five sites, provides the most closed cavity. The temperature obtained through the rectal route measures approximately 1°F higher than the same person's temperature taken through the oral route (see Table 19-2). The medical assistant should make a notation on the patient's chart if the temperature has been taken rectally.

The rectal method is generally used for infants and young children, unconscious patients, and mouth-breathing patients and when greater accuracy in body temperature is desired. The rectal site should not be used with newborns because of the danger of rectal trauma.

Aural Temperature

The aural (ear) site is used with the tympanic membrane thermometer. The ear provides a closed cavity that is easily accessible. Tympanic membrane thermometers provide instantaneous results, are easy to use, and are comfortable for the patient. They make it easier to measure the temperature of children younger than 6 years, uncooperative patients, and patients who are unable to have their temperatures taken orally.

Forehead Temperature

The temporal artery is a major artery of the head that runs laterally across the forehead and down the side of the neck. In the area of the forehead, it is located approximately 2 mm below the surface of the skin. Because the temporal artery is located so close to the skin surface and is easily accessible, the forehead provides an ideal site for obtaining a body temperature measurement. In addition, the temporal artery has a constant steady flow of blood, which assists in providing an accurate measurement of the patient's body temperature.

The forehead site can be used to measure body temperature using a temporal artery thermometer in individuals of all ages (newborns, infants, children, adults, elderly). The results compare in accuracy with other methods used to measure body temperature. The temperature obtained through the forehead site is about the same as a rectal temperature measurement. The temporal artery reading measures approximately 1 degree higher than oral body temperature and 2 degrees higher than axillary temperature on the Fahrenheit scale.

Putting It All into Practice

My name is Sergio Martinez, and I am a registered medical assistant. I work in a large clinic that is associated with a medical school. At present, I work in the family medicine department, but I also have worked in dermatology and internal medicine. Family medicine is the area I enjoy most because of the wide variety of tasks that are performed. There is rarely a dull moment.

I focus primarily on clinical medical assisting. Taking vital signs is a big part of my job responsibilities. It is routine at my clinic to take height, weight, temperature, pulse, respiration, and blood pressure on every patient seen at the clinic, no matter what the reason for his or her visit. I assist the physician with various procedures, examinations, and minor office surgery, and I administer injections, run electrocardiograms, and perform various laboratory tests.

Taking vital signs and length and weight on small children can be very challenging at times. Some children start to cry as soon as they are put on the scale. Taking a temperature on an uncooperative toddler can be very difficult. I try to calm the child as much as possible, and for good behavior, I give a lot of praise. Stickers also are a great reward for cooperative behavior. Usually when small children learn that they can trust you, they are not as frightened by the experience. It is rewarding when a child learns not to be afraid of being evaluated for routine vital signs. ■

Prepare for Success

Types of Thermometers

The four types of thermometers available for measuring body temperature are electronic thermometers, tympanic membrane thermometers, temporal artery thermometer, and chemical thermometers. Mercury glass thermometers, previously commonly used in medical offices, are no longer used because they break easily and release mercury. Mercury is a chemical that is dangerous to the human body because it can cause damage to the nervous system. If mercury is released into the environment, it can be harmful to wildlife. Many cities have banned the sale or use of mercury because of its potential hazards.

Electronic Thermometer

An electronic thermometer is frequently used in the medical office to measure body temperature. Electronic thermometers are portable and measure oral, axillary, and rectal temperatures ranging from 84°F to 108°F (28.9°C to 42.2°C).

An electronic thermometer measures body temperature in a brief time; the time varies between 4 and 20 seconds, depending on the brand of thermometer. The temperature results are digitally displayed on an LCD screen. An electronic thermometer consists of interchangeable oral and rectal probes attached to a battery-operated portable unit (Figure 19-4). The probes are color-coded for ease in identifying them. The oral probe is color-coded with blue on its collar and is used to take oral and axillary temperatures; the rectal probe is color-coded with red on its collar and is used to take rectal temperatures only.

A disposable plastic cover is placed over the probe to prevent the transmission of microorganisms among patients. Depending on the method of taking the temperature, the probe is inserted in the mouth, axilla, or rectum and is left in place until an audible tone is emitted from the thermometer. When the tone sounds, the patient's temperature in degrees Fahrenheit is displayed on the screen. The medical assistant ejects the plastic probe cover into a regular waste container.

The casing, probes, and attached cords of the electronic thermometer should be periodically cleaned with a soft cloth slightly dampened with a solution of warm water and a disinfectant cleaner.

Procedures 19-1, 19-2, and 19-3 outline the methods for measuring oral, axillary, and rectal temperature using an electronic thermometer.

Tympanic Membrane Thermometer

The tympanic membrane thermometer is used at the aural site. The tympanic membrane thermometer functions by detecting thermal energy that is naturally radiated from the body. As with the rest of the body, the tympanic membrane gives off heat waves known as *infrared waves.* The tympanic thermometer functions like a camera by taking a "picture" of these infrared waves, which are considered a documented indicator of body temperature (Figure 19-5). The thermometer calculates the body temperature from the energy generated by the waves and converts it to an oral or rectal equivalent.

The tympanic membrane thermometer is battery operated and consists of a small handheld device with a sensor probe (Figure 19-6). To operate the thermometer, the probe

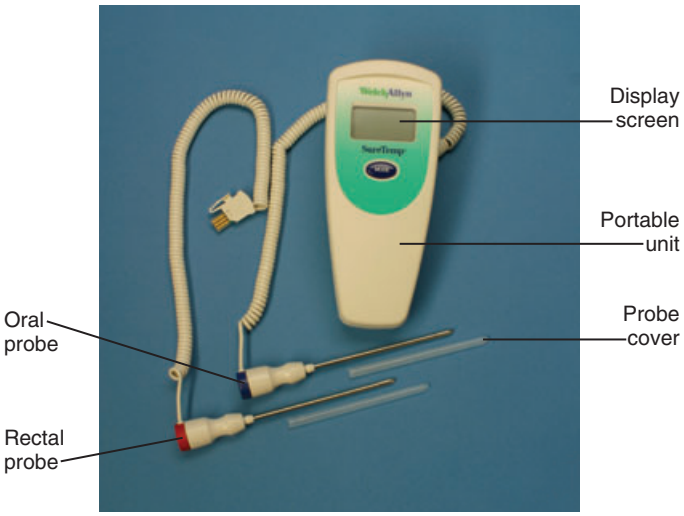


Figure 19-4. Electronic thermometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

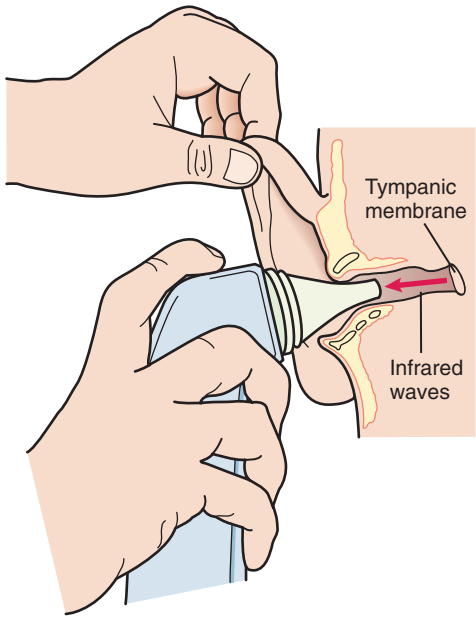


Figure 19-5. The tympanic membrane thermometer functions by detecting thermal energy that is naturally radiated from the tympanic membrane. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

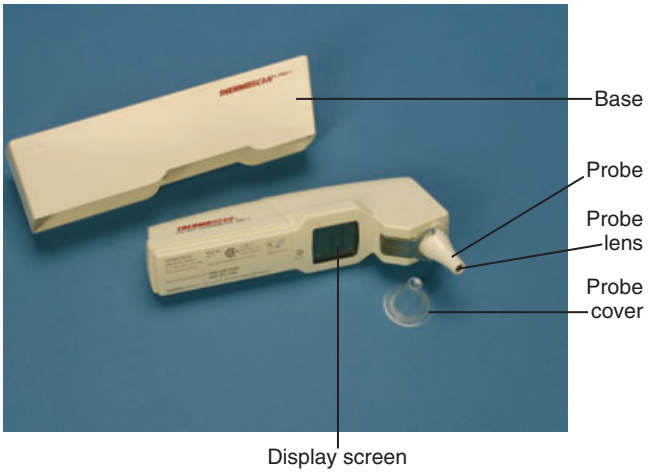


Figure 19-6. Tympanic membrane thermometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

is covered with a disposable soft plastic cover and placed in the outer third of the external ear canal. An activation button is depressed momentarily, and the results are displayed in 1 to 2 seconds on a digital screen. The probe cover is ejected into a regular waste container. The procedure for taking aural body temperature using a tympanic membrane thermometer is presented in Procedure 19-4.

Temporal Artery Thermometer

Measuring temperature using a temporal artery thermometer is the newest method for assessing body temperature. A temporal artery thermometer is an electronic device consisting of a probe attached to a portable unit (Figure 19-7).

To perform the procedure, a scan button is continually depressed while the probe is gently and slowly moved across the patient's forehead. During this process, the probe sensor scans the forehead for the infrared heat given off by the temporal artery. The probe sensor captures the highest

Guidelines for Using a Tympanic Membrane Thermometer

The following guidelines help ensure accurate aural temperature measurement with a tympanic membrane thermometer.

1. **Determine whether a tympanic thermometer can be used to measure the patient's temperature.** The tympanic thermometer should not be used on a patient with inflammation of the external ear canal (e.g., otitis externa) or when the ear contains a discharge, such as blood or pus. The presence of otitis media and tympanostomy tubes does not significantly affect the temperature reading; a normal amount of cerumen also has no effect. An excessive buildup of cerumen that occludes the ear canal can result in a falsely low temperature reading.
2. **Determine whether external factors are present that may influence the temperature reading.** If any of these factors are present, remove the individual from the situation and wait 20 minutes before taking the temperature. External factors include an individual who has been lying on one ear or the other; who has had the ears covered (e.g., hat, ear muffs); who has been exposed to very hot or very cold temperatures; or who has been recently swimming or bathing.
3. **Select the temperature measurement system desired.** The temperature of a tympanic membrane thermometer can be displayed in degrees Fahrenheit or degrees Celsius. Follow the manufacturer's instructions to change from one measurement to the other.
4. **Place the probe properly in the patient's ear.** The most important factor in obtaining an accurate temperature is the proper placement of the probe in the patient's ear, which is outlined as follows.
   - **Straighten the ear canal.** The ear canal has an S shape that obstructs the view of the tympanic membrane. To obtain an accurate temperature measurement, the ear canal must be straightened before inserting the probe. This allows the probe sensor to obtain a clear picture of the tympanic membrane.
   - **Seal the opening of the ear.** The probe must be inserted tightly enough to seal the opening of the ear without causing patient discomfort. If the probe does not seal the ear canal, cooler external air can cause the thermometer to register a lower temperature.
   - **Correctly position the probe.** Position the tip of the probe toward the opposite temple (approximately midway between the opposite ear and eyebrow). This allows the sensor to obtain the best possible picture of the tympanic membrane. If the tip is positioned incorrectly, it may be aimed at the ear canal, which results in a falsely low reading.
5. **Verify the accuracy of the temperature reading, if needed.** If you need to take the patient's temperature again, you can use the other ear. Slight but insignificant differences occur between the temperature readings in the right ear and the left ear. Before using the same ear, however, you must wait 2 minutes to allow the aural temperature to stabilize.
6. **Check the probe lens before taking the temperature.** The end of the probe is covered with a lens that is transparent to heat waves. To ensure a high level of accuracy, it is extremely important to keep this lens clean and intact. Before taking a temperature, always check to ensure that the lens is shiny and clear. Fingerprints, cerumen, and dust reduce the transparency of the lens, resulting in falsely low temperature readings. If the lens is dirty, it must be cleaned before taking the patient's temperature. If the lens is damaged, the thermometer cannot be used and must be repaired.

Continued

Guidelines for Using a Tympanic Membrane Thermometer—cont'd

7. **Respond appropriately to digital messages.** A message to alert the user is displayed in the digital screen under the following circumstances:
   - An attempt is made to take a temperature without changing the cover after the last temperature.
   - An attempt is made to take a temperature with no probe cover in place.
   - The battery is low.
   - The thermometer is in need of repair.
8. Care for the tympanic thermometer properly.
   - **Probe lens.** Dust and other minute particles of environmental debris can build up on the probe lens during normal use. The lens should be cleaned as part of routine maintenance or when it becomes dirty. To clean the lens, gently wipe its surface with an antiseptic wipe and immediately wipe it dry with a cotton swab. After cleaning, allow at least 5 minutes before taking a temperature.
   - **Thermometer casing.** Clean the casing of the thermometer periodically by wiping it dry with a soft cloth slightly dampened with a solution of warm water and a disinfectant cleaner. Make sure the cloth is damp but not wet to prevent the disinfectant solution from running inside the thermometer, which could damage it.
9. **Store the thermometer properly.** Keep the thermometer away from temperature extremes, which could damage the thermometer. The thermometer should not be exposed to excessive heat (greater than 95°F [35°C]) or excessive cold (less than 60°F [15.6°C]).

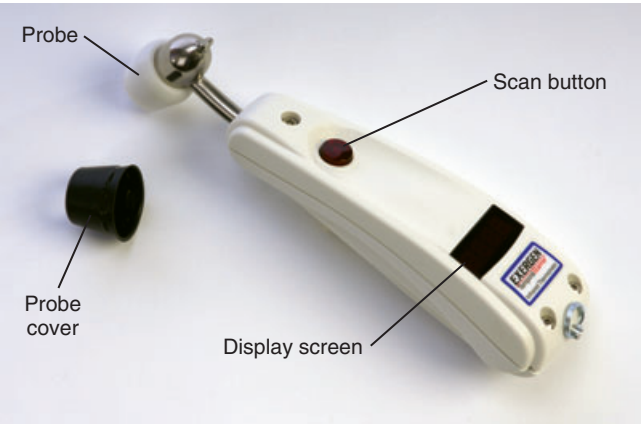


Figure 19-7. Temporal artery thermometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

temperature or *peak temperature* in the area being scanned. The peak temperature represents the temperature given off by the temporal artery or body temperature.

Along with measuring the peak temperature, the probe sensor automatically measures the *ambient temperature,* which is the surrounding air temperature. This is done because there is a small heat loss from the forehead as a result of cooling by ambient temperature. The thermometer's computer determines and automatically corrects for any effect from ambient temperature. An accurate body temperature reading is digitally displayed on the screen on the thermometer. The procedure for measuring temperature using a temporal artery thermometer is presented in Procedure 19-5.

Earlobe Temperature Measurement

Sweating of the forehead can cause an inaccurate temporal artery temperature reading. This is because perspiration causes the skin of the forehead to cool, resulting in a falsely low temperature reading. Sweating of the forehead occurs when a patient's fever breaks. It also occurs when a patient's skin is clammy; in this instance, forehead sweating may be present but not readily visible. To avoid this problem, the temperature of the neck area located just behind the earlobe also must be measured.

The area behind the earlobe is less affected by sweating than the forehead. During sweating, the blood vessels behind the earlobe dilate, resulting in a constant, steady flow of blood, which provides an accurate measurement of body temperature. After scanning the forehead, the medical assistant must place the probe of the thermometer in the soft depression of the neck just below the mastoid process of the ear. If the patient's forehead has cooled from sweating, the earlobe temperature automatically registers as the peak temperature, thereby overriding the forehead temperature.

The area behind the earlobe does not normally provide an accurate body temperature measurement and supersedes the forehead measurement only when the patient is in a diaphoretic state. Additional guidelines for temporal artery temperature measurement are presented in Box 19-1.

Care and Maintenance

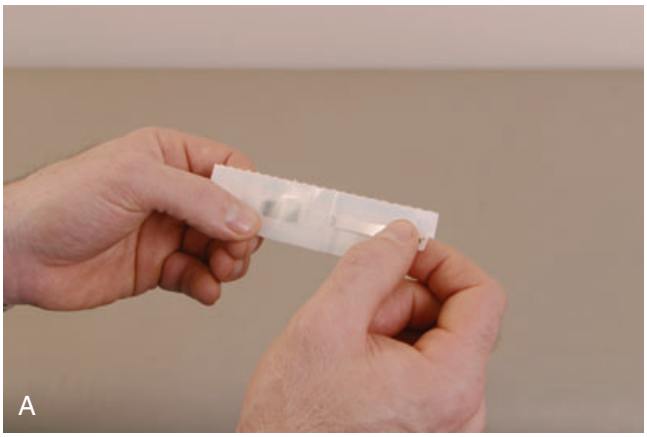
The temporal artery thermometer should be stored in a clean, dry area. The thermometer must be protected from extremes in temperature, direct sunlight, and dust. The casing of the thermometer should be cleaned periodically with a soft cloth moistened with a solution of warm water and a disinfectant cleaner; never splash water on or immerse the unit in water because this could damage the internal components of the thermometer.

To obtain an accurate measurement, the probe lens must be clean and shiny. Dust and other minute particles of environmental debris can build up on the probe lens during normal use, preventing the probe sensor from getting an accurate "view" of the heat emitted by the temporal artery

BOX 19-1 Temporal Artery Thermometer Guidelines

1. The operating environmental temperature for a temporal artery thermometer is 60°F to 104°F (15.5°C to 40°C).
2. Do not take temperature over scar tissue, open sores, or abrasions.
3. Ensure that the side of the head to be measured is exposed to the environment. Anything covering the area to be measured (e.g., hair, hat, wig, bandages) traps body heat, resulting in a falsely high reading.
4. A falsely low temporal artery reading can result from the following:
   - A dirty probe lens
   - Sweating of the forehead (in this instance, the earlobe measurement becomes the overriding temperature reading)
   - Scanning the forehead too quickly
   - Not keeping the button depressed while scanning the forehead and area behind the earlobe

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.



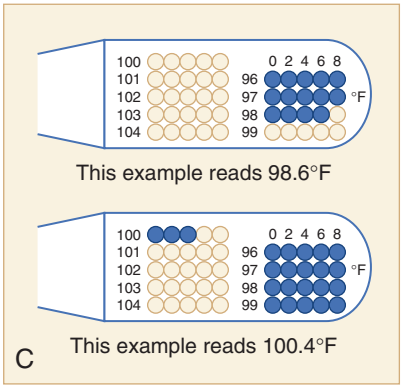


Figure 19-8. Disposable chemical single-use thermometers. **A,** The thermometer is removed from the wrapper by pulling on the handle. **B,** The thermometer is inserted under the tongue and left in place for 60 seconds. **C,** The thermometer is read by noting the highest reading among the dots that have changed color. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

and resulting in a falsely low reading. The lens should be cleaned if it becomes dirty and as part of routine maintenance. The lens is cleaned by gently wiping its surface with an antiseptic wipe and immediately wiping it dry with a cotton-tipped applicator stick.

Chemical Thermometers

Chemical thermometers contain chemicals that are heat sensitive and include disposable chemical single-use thermometers and temperature-sensitive strips. They are used most often by patients at home to measure body temperature. Although chemical thermometers are less accurate than other types of thermometers, they assist in providing a general assessment of body temperature. Because of their chemical makeup, they should be stored in a cool area, preferably colder than 86°F (30°C), and should not be exposed to direct sunlight because heat may cause the thermometer to register a higher temperature. Each type of chemical thermometer is described here.

Disposable Chemical Single-Use Thermometers

The disposable chemical single-use thermometer has small chemical dots at one end that respond to body heat by changing color (Figure 19-8A and B). Each thermometer comes in its own wrapper. The protective wrapper must be peeled back to expose the handle of the thermometer. The thermometer is removed from the wrapper by pulling on the handle, taking care not to touch the dotted area. The thermometer is inserted under the tongue and left in place for the duration of time recommended by the manufacturer (generally 60 seconds). After removal of the thermometer, the dots are observed for a change in color. The thermometer is read by noting the highest reading among the dots

that have changed color (Figure 19-8C). The thermometer is discarded after use.

Temperature-Sensitive Strips

A temperature-sensitive strip consists of a reusable plastic strip that contains heat-sensitive liquid crystals designed to measure body temperature. The plastic strip is pressed onto the forehead and held in place until the colors stop changing, generally 15 seconds. The results are read by observing the color change and noting the corresponding temperature indicated on the strip (Figure 19-9).

Text continued on p. 346

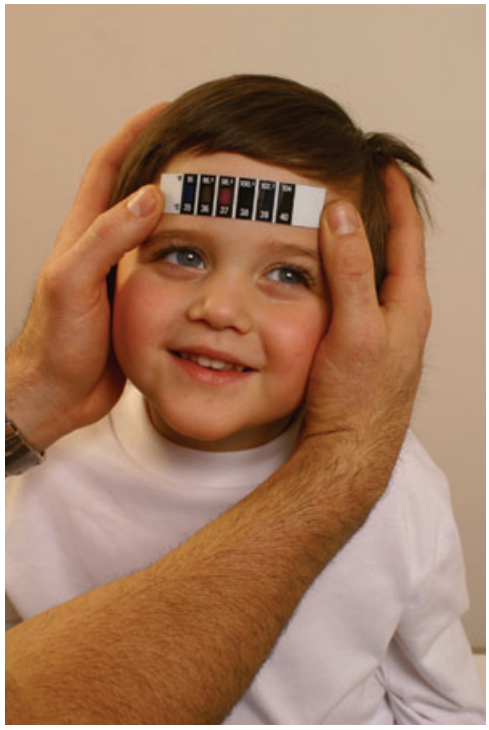


Figure 19-9. Temperature-sensitive strip. The plastic strip is pressed onto the forehead and held in place until the color stops changing (generally 15 seconds). The results are read by observing the color and noting the corresponding temperature indicated on the strip. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

What Would You Do? What Would You *Not* Do?

Case Study 1

Marcela Mason comes in with Olivia, her 5-year-old daughter. Olivia has had a fever and sore throat for the past 2 days. Olivia's aural temperature is taken in her left ear, and it measures 103.3°F. Mrs. Mason says that she has an ear thermometer at home, but when she took Olivia's temperature with it, the readings were always below 97°F. She knew that could not be right because Olivia felt so warm. Mrs. Mason would like to be able to use her ear thermometer, but she thinks that it might be broken because of the low readings. Mrs. Mason says that she is thinking of switching back to a mercury glass thermometer, but she has heard that it is not a good idea to use this type of thermometer anymore and wants to know why. ■

PROCEDURE 19-1

see DVD

PROCEDURE 19-1 Measuring Oral Body Temperature—Electronic Thermometer

Outcome Measure oral body temperature.

Equipment/Supplies

- Electronic thermometer
- Oral probe (blue collar)
- Plastic probe cover
- Waste container

1. **Procedural Step.** Sanitize your hands, and assemble the equipment.
2. **Procedural Step.** Remove the thermometer unit from its storage base, and attach the oral (blue collar) probe to it. This is accomplished by inserting the latching plug (at the end of the coiled cord of the oral probe) to the plug receptacle on the thermometer unit until it clicks into place. Insert the probe into the face of the thermometer.
   Principle. The oral probe is color-coded with a blue collar for ease in identifying it.
3. **Procedural Step.** Greet the patient and introduce yourself. Identify the patient and explain the procedure. If the patient has recently ingested hot or cold food or beverages or has been smoking, you must wait 15 to 30 minutes before taking the temperature.
   Principle. Ingestion of hot or cold food or beverages and smoking changes the temperature of the mouth, which could result in an inaccurate reading.
4. **Procedural Step.** Grasp the probe by the collar, and remove it from the face of the thermometer. Slide the probe into a disposable plastic probe cover until it locks into place.
   Principle. Removing the probe from the thermometer automatically turns on the thermometer. The probe cover prevents the transfer of microorganisms from one patient to another.
5. **Procedural Step.** Take the patient's temperature by inserting the probe under the patient's tongue in the pocket located on either side of the frenulum linguae. Instruct the patient to keep the mouth closed.

Principle. There is a good blood supply in the tissue under the tongue. The mouth must be kept closed to prevent cooler air from entering and affecting the temperature reading.

Attach the oral probe to the thermometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Slide the probe into a probe cover. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Insert the probe under the patient's tongue. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

6. Procedural Step. Hold the probe in place until you hear the tone. At that time, the patient's temperature appears as a digital display on the screen. Make a mental note of the temperature reading. (The temperature indicated on this thermometer is 98.2°F [36.8°C]).

The patient's temperature appears as a digital display on the screen. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

PROCEDURE 19-1

Continued

PROCEDURE 19-1 Measuring Oral Body Temperature—Electronic Thermometer—cont'd

7. Procedural Step. Remove the probe from the patient's mouth. Discard the probe cover by firmly pressing the ejection button while holding the probe over a regular waste container. Do not allow your fingers to come in contact with the probe cover.
Principle. The probe cover should not be touched so as to prevent the transfer of microorganisms from the patient to the medical assistant. Saliva is not considered regulated medical waste; the probe can be discarded in a regular waste container.

8. Procedural Step. Return the probe to its stored position in the thermometer unit. Return the thermometer unit to its storage base.
Principle. Returning the probe to the unit automatically turns off and resets the thermometer.

9. Procedural Step. Sanitize your hands, and chart the results. Include the date, time, and temperature reading.
Principle. Patient data must be recorded properly to aid the physician in the diagnosis and to provide future reference.

Discard the probe cover by pressing the ejection button. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

CHARTING EXAMPLE

Date	
10/15/10	2:15 p.m. T: 98.2° F. —S. Martinez, RMA

see DVD

PROCEDURE 19-2 Measuring Axillary Body Temperature—Electronic Thermometer

Outcome Measure axillary body temperature. *Note:* Many of the principles for taking temperature already have been stated and are not included in this procedure.

Equipment/Supplies

- Electronic thermometer
- Oral probe (blue collar)
- Plastic probe cover
- Waste container

1. Procedural Step. Sanitize your hands, and assemble the equipment.

2. Procedural Step. Remove the thermometer unit from its storage base, and attach the oral (blue collar) probe to it. This is accomplished by inserting the latching plug (on the end of the coiled cord of the oral probe) to the plug receptacle on the thermometer unit until it locks into place. Insert the probe into the face of the thermometer.

3. Procedural Step. Greet the patient and introduce yourself. Identify the patient and explain the procedure.

4. Procedural Step. Remove clothing from the patient's shoulder and arm. Ensure that the axilla is dry. If it is wet, pat it dry with a paper towel or a gauze pad.
Principle. Clothing removal provides optimal exposure of the axilla for proper placement of the thermometer. Rubbing the axilla causes an increase in the

temperature in that area owing to friction, resulting in an inaccurate temperature reading.

5. **Procedural Step.** Grasp the probe by the collar, and remove it from the face of the thermometer. Slide the probe into a disposable probe cover until it locks into place.

6. **Procedural Step.** Take the patient's temperature by placing the probe in the center of the patient's axilla. Instruct the patient to hold the arm close to the body. Hold the arm in place for small children and other patients who cannot maintain the position themselves.

Principle. Interference from outside air currents is reduced when the arm is held in the proper position.

Place the probe in the center of the patient's axilla. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

7. **Procedural Step.** Hold the probe in place until you hear the tone. At that time, the patient's temperature appears as a digital display on the screen. Make a mental note of the temperature reading.

8. **Procedural Step.** Remove the probe from the patient's axilla. Discard the probe cover by firmly pressing the ejection button while holding the probe over a regular waste container. Do not allow your fingers to come in contact with the probe cover.

9. **Procedural Step.** Return the probe to its stored position in the thermometer unit. Return the thermometer unit to its storage base.

Return the thermometer to its base. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

10. **Procedural Step.** Sanitize your hands, and chart the results. Include the date, time, and axillary temperature reading. The symbol Ⓐ must be charted next to the temperature reading to tell the physician that an axillary reading was taken.

CHARTING EXAMPLE

Date	
10/15/10	9:30 a.m. T: 97.4° F Ⓐ –S. Martinez, RMA

PROCEDURE 19-2

PROCEDURE 19-3 Measuring Rectal Body Temperature—Electronic Thermometer

Outcome Measure rectal body temperature.

Equipment/Supplies

- Electronic thermometer
- Rectal probe (red collar)
- Plastic probe cover
- Lubricant
- Disposable gloves
- Tissues
- Waste container

1. **Procedural Step.** Sanitize your hands, and assemble the equipment.
2. **Procedural Step.** Remove the thermometer unit from its storage base. Attach the rectal (red collar) probe to it. This is accomplished by inserting the latching plug (on the end of the coiled cord of the rectal probe) to the plug receptacle on the thermometer unit. Insert the probe into the face of the thermometer.
   Principle. The rectal probe is color-coded with a red collar for ease in identifying it.
3. **Procedural Step.** Greet the patient and introduce yourself. Identify the patient and explain the procedure. If a patient is a child or an adult, provide him or her with a patient gown. Instruct the patient to remove enough clothing to provide access to the anal area and to put on the gown with the opening in the back. If the patient is an infant, ask the parent to remove his or her diaper.
   Principle. It is important to explain what you will be doing because body temperature may be higher in a fearful or apprehensive patient. The patient gown provides the patient with modesty and comfort.
4. **Procedural Step.** Apply gloves. Position the patient. ***Adults and children:*** Position the patient in the Sims position, and drape the patient to expose only the anal area. ***Infants:*** Position the infant on his or her abdomen.
   Principle. Gloves protect the medical assistant from microorganisms in the anal area and feces. Correct positioning allows clear viewing of the anal opening and provides for proper insertion of the thermometer. Draping reduces patient embarrassment and provides warmth.
5. **Procedural Step.** Grasp the probe by the collar, and remove it from the face of the thermometer. Slide the probe into a disposable plastic probe cover until it locks into place. Apply a lubricant to the tip of the probe cover up to a level of 1 inch.
   Principle. A lubricated thermometer can be inserted more easily and does not irritate the delicate rectal mucosa.

Apply a lubricant to the tip of the probe cover. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

6. **Procedural Step.** Instruct the patient to lie still. Separate the buttocks to expose the anal opening, and gently insert the thermometer probe approximately 1 inch into the rectum of an adult, ⅝ inch in children, and ½ inch in infants. Do not force insertion of the probe. Hold the probe in place until the temperature registers.

Gently insert the probe ½ inch into the rectum. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Principle. The probe must be inserted correctly to prevent injury to the tissue of the anal opening. The probe should be held in place to prevent damage to the rectal mucosa.

7. **Procedural Step.** Hold the probe in place until you hear the tone. At that time, the patient's temperature appears as a digital display on the screen. Make a mental note of the temperature reading.
8. **Procedural Step.** Gently remove the probe from the rectum in the same direction as it was inserted. Avoid touching the probe cover. Discard the probe cover by firmly pressing the ejection button while holding the probe over a regular waste container. Return the probe to its stored position in the thermometer unit. Return the thermometer unit to its storage base.
   Principle. Fecal material is not considered regulated medical waste; the probe can be discarded in a regular waste container.
9. **Procedural Step.** Wipe the patient's anal area with tissues to remove excess lubricant. Dispose of the tissues in a regular waste container.
   Principle. Wiping the anal area makes the patient more comfortable.
10. **Procedural Step.** Remove gloves, and sanitize your hands. Chart the results. Include the date, time, and rectal temperature reading. The symbol Ⓡ must be charted next to the temperature reading to tell the physician that a rectal reading was taken.

CHARTING EXAMPLE

Date	
10/15/10	11:15 a.m. T: 99.8° F Ⓡ — S. Martinez, RMA

see DVD

PROCEDURE 19-4 Measuring Aural Body Temperature—Tympanic Membrane Thermometer

Outcome Measure aural body temperature.

Equipment/Supplies

- Tympanic membrane thermometer
- Probe cover
- Waste container

1. **Procedural Step.** Sanitize your hands, and assemble the equipment.
   Principle. Your hands should be clean and free from contamination.
2. **Procedural Step.** Greet the patient and introduce yourself. Identify the patient and explain the procedure.
   Principle. It is important to explain what you will be doing because body temperature may be higher in a fearful or apprehensive patient.
3. **Procedural Step.** Remove the thermometer from its storage base. Ensure that the probe lens is clean and intact.
   Principle. A dirty or damaged probe lens could result in a falsely low temperature reading.
4. **Procedural Step.** Place a cover on the probe by pressing the probe tip straight down into the cover box. You will be able to see and feel the cover snap securely into place on the probe. This procedure automatically turns on the thermometer.
   Principle. The probe cover protects the lens and provides infection control. The cover must be seated securely on the probe to activate the thermometer.

Place a cover on the probe. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Continued

PROCEDURE 19-4 Measuring Aural Body Temperature—Tympanic Membrane Thermometer—cont'd

5. Procedural Step. Pull the probe straight up from the cover box. Look at the digital display to see if the thermometer is ready to use.

When the thermometer is ready, it displays the word "READY." (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

6. Procedural Step. Hold the thermometer in your dominant hand. If you are right handed, you should take the temperature in the patient's right ear. If you are left handed, take the temperature in the patient's left ear.

Principle. Taking the temperature with the dominant hand assists in the proper placement of the probe in the patient's ear.

7. Procedural Step. Straighten the patient's external ear canal with your nondominant hand, as follows:

Adults and Children Older Than 3 Years Old. Gently pull the ear auricle upward and backward.

Children Younger Than 3 Years Old. Gently pull the ear pinna downward and backward.

Principle. Straightening the ear canal allows the probe sensor to obtain a clear picture of the tympanic membrane, resulting in an accurate temperature measurement.

Straighten the canal of adults and children older than 3 years by pulling the ear auricle upward and backward. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Straighten the canal of children younger than 3 years by pulling the ear auricle downward and backward. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

8. Procedural Step. Insert the probe into the patient's ear canal tightly enough to seal the opening, but without causing patient discomfort. Point the tip of the probe toward the opposite temple (approximately midway between the opposite ear and eyebrow).

Principle. Sealing the ear canal prevents cooler external air from entering the ear, which could result in a falsely low reading. Correct positioning of the probe optimizes the sensor's view of the tympanic membrane, leading to an accurate temperature reading.

9. Procedural Step. Ask the patient to remain still. Hold the thermometer steady, and depress the activation button. Depending on the brand of the thermometer, perform one of the following:

a. Hold the button down for one full second, and then release it, *or*
b. Hold down the button down until an audible tone is heard.

Principle. The thermometer cannot take a temperature unless the activation button is depressed for 1 full second. When the button is depressed, the infrared sensor in the probe scans the thermal energy radiated by the tympanic membrane.

10. Procedural Step. Remove the thermometer from the ear canal. Turn the digital display of the thermometer toward you, and read the temperature. Make a mental note of the temperature reading. If the temperature seems to be too low, repeat the procedure to ensure that you have used the proper technique. The temperature indicated on this thermometer is 98°F (37.2°C).

Principle. The temperature remains on the display screen until another cover is inserted on the probe. Improper technique can result in a falsely low temperature reading.

Read the temperature on the digital display. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

11. Procedural Step. Dispose of the probe cover by ejecting it into a regular waste container.

Dispose of the probe cover. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

12. Procedural Step. Replace the thermometer in its storage base.

Principle. The thermometer should be stored in its base to protect the probe lens from damage and dirt.

13. Procedural Step. Sanitize your hands.

14. Procedural Step. Chart the results. Include the date, time, aural temperature reading, and which ear was used to take the temperature (AD: right ear; AS: left ear). Using these abbreviations, the physician knows that the temperature was taken through the aural route.

CHARTING EXAMPLE

Date	
10/15/10	3:00 p.m. T: 98° F, AD —S. Martinez, RMA

PROCEDURE 19-4

PROCEDURE 19-5 Measuring Temporal Artery Body Temperature

Outcome Measure temporal artery body temperature.

Equipment/Supplies

- Temporal artery thermometer
- Probe cover
- Antiseptic wipe
- Waste container

1. **Procedural Step.** Sanitize your hands, and assemble the equipment.
2. **Procedural Step.** Greet the patient and introduce yourself. Identify the patient and explain the procedure.
3. **Procedural Step.** Examine the probe lens of the temporal artery thermometer to ensure that the lens is clean and intact.
   Principle. A dirty or damaged probe lens could result in a falsely low temperature reading.
4. **Procedural Step.** Place a disposable cover over the probe. If the thermometer does not use disposable covers, clean the probe with an antiseptic wipe and allow it to dry.
   Principle. Applying a probe cover or cleaning the probe with an antiseptic wipe provides infection control.

Place a disposable probe cover on the thermometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

5. **Procedural Step.** Select an appropriate site; the right or left forehead can be used. The site selected should be fully exposed to the environment.
   Principle. The temporal artery is located in the center of each side of the forehead, approximately 2 mm below the surface of the skin.
6. **Procedural Step.** Prepare the patient by brushing away any hair that is covering the side of the forehead to be scanned and the area behind the earlobe on the same side.
   Principle. Hair covering the area to be measured traps body heat, resulting in a falsely high temperature reading.
7. **Procedural Step.** Hold the thermometer in your dominant hand with your thumb on the scan button.
8. **Procedural Step.** Gently position the probe of the thermometer on the center of the patient's forehead, midway between the eyebrow and the hairline.

Position the probe on the center of the patient's forehead. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

9. **Procedural Step.** Depress the scan button, and keep it depressed for the entire measurement.
   Principle: Not keeping the scan button depressed can result in a falsely low temperature reading.
10. **Procedural Step.** Slowly and gently slide the probe straight across the forehead, midway between the eyebrow and the upper hairline. Continue until the hairline is reached. Keep the scan button depressed and the probe flush (flat) against the forehead. During this time, a beeping sound occurs and a red light blinks to indicate a measurement is taking place. Rapid beeping and blinking indicate a rise to a higher temperature. A slow beeping indicates that the thermometer is still scanning but not finding a higher temperature.
    Principle. The thermometer continually scans for the peak temperature as long as the scan button is depressed. The probe must be held flat against the forehead to ensure accurate scanning of the temporal artery.

10

Slowly slide the probe straight across the patient's forehead. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

11. Procedural Step. Keeping the button depressed, lift the probe from the forehead, and gently place the probe behind the earlobe in the soft depression of the neck just below the mastoid process. Hold the probe in place for 1 to 2 seconds.
Principle. Taking the patient's temperature behind the earlobe prevents an error in temperature measurement in the event that the patient is sweating.

11

Place the probe behind the ear lobe. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

12. Procedural Step. Release the scan button on the digital display, and read the temperature. Make a mental note of the temperature reading (The temperature indicated on this thermometer is 99.1°F [37.3°C]). The reading remains on the display for approximately 15 to 30 seconds after the button is released. The thermometer shuts off automatically after 30 seconds. To turn the thermometer off immediately, press and release the scan button quickly. If the patient's temperature needs to be taken again, wait 60 seconds or use the opposite side of the forehead.
Principle. Taking a measurement cools the skin, and taking another measurement too soon may result in an inaccurate reading.

12

Read the temperature. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

13. Procedural Step. Dispose of the probe cover by pushing it off the probe with your thumb and ejecting it into a regular waste container. Wipe the probe with an antiseptic wipe, and allow it to dry.

13

Wipe the probe with an antiseptic wipe. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Continued

PROCEDURE 19-5 Measuring Temporal Artery Body Temperature—cont'd

14. Procedural Step. Sanitize your hands, and chart the results. Include the date, time, and temperature reading. The symbol (TA) must be charted next to the temperature reading to tell the physician that a temporal artery reading was taken. Store the thermometer in a clean, dry area.

CHARTING EXAMPLE

Date	
10/15/10	9:15 a.m. T: 99.1° F(TA)— S. Martinez, RMA

Table 19-4 Pulse Rates of Various Age Groups

Age Group	Pulse Range (beats/min)	Average Pulse (beats/min)
Infant (birth to 1 yr)	120-160	140
Toddler (1-3 yr)	90-140	115
Preschool child (3-6 yr)	80-110	95
School-age child (6-12 yr)	75-105	90
Adolescent (12-18 yr)	60-100	80
Adult (after 18th yr)	60-100	80
Adult (after 60th yr)	67-80	74
Well-trained athletes	40-60	50

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.

PULSE

Mechanism of the Pulse

When the left ventricle of the heart contracts, blood is forced from the heart into the **aorta,** which is the major trunk of the arterial system of the body. The aorta is already filled with blood and must expand to accept the blood being pushed out of the left ventricle. This creates a pulsating wave that travels from the aorta through the walls of the arterial system. This wave, known as the *pulse,* can be felt as a light tap by an examiner. The pulse rate is measured by counting the number of "taps," or beats per minute. The heart rate can be determined by taking the pulse rate.

Factors Affecting Pulse Rate

Pulse rate can vary depending on many factors. The medical assistant should take each of the following into consideration when measuring pulse:

1. **Age.** The pulse varies inversely with age. As the age increases, the pulse rate gradually decreases. Table 19-4 lists the pulse rates of the various age groups.
2. **Gender.** Women tend to have a slightly faster pulse rate than men.
3. **Physical activity.** Physical activity, such as jogging and swimming, increases the pulse rate temporarily.
4. **Emotional states.** Strong emotional states, such as anxiety, fear, excitement, and anger, temporarily increase the pulse rate.
5. **Metabolism.** Increased body metabolism, such as occurs during pregnancy, increases the pulse rate.
6. **Fever.** Fever increases the pulse rate.
7. **Medications.** Medications may alter the pulse rate. For example, digitalis decreases the pulse rate, and epinephrine increases it.

Pulse Sites

The pulse is felt most strongly when a superficial artery is held against a firm tissue, such as bone. The locations of the sites used for measuring the pulse are shown in Figure 19-10 and are described next.

Radial The most common site for measuring the pulse is the radial artery, which is located in a groove on the inner aspect of the wrist just below the thumb. The radial pulse is easily accessible and can be measured with no discomfort to the patient. This site is also used by individuals at home monitoring their own heart rates, such as athletes, patients taking heart medication, and individuals starting an exercise program. The procedure for measuring radial pulse is outlined in Procedure 19-6.

Apical The apical pulse has a stronger beat and is easier to measure than the other pulse sites. If the medical assistant is having difficulty feeling the radial pulse or if the radial pulse is irregular or abnormally slow or rapid, the apical pulse should be taken (Procedure 19-7). This pulse site is often used to measure pulse in infants and in children up to 3 years old because the other sites are difficult to palpate accurately in these age groups. The apical pulse is measured using a stethoscope. The chest piece of the stethoscope is placed lightly over the apex of the heart, which is located in the fifth **intercostal** (between the ribs) space at the junction of the left midclavicular line (Figure 19-11).

Brachial The brachial pulse is in the **antecubital space,** which is the space located at the front of the elbow. This site is used to take blood pressure, to measure pulse in infants during cardiac arrest, and to assess the status of the circulation to the lower arm.

Ulnar The ulnar pulse is located on the ulnar (little finger) side of the wrist. It is used to assess the status of circulation to the hand.

Temporal The temporal pulse is located in front of the ear and just above eye level. This site is used to measure

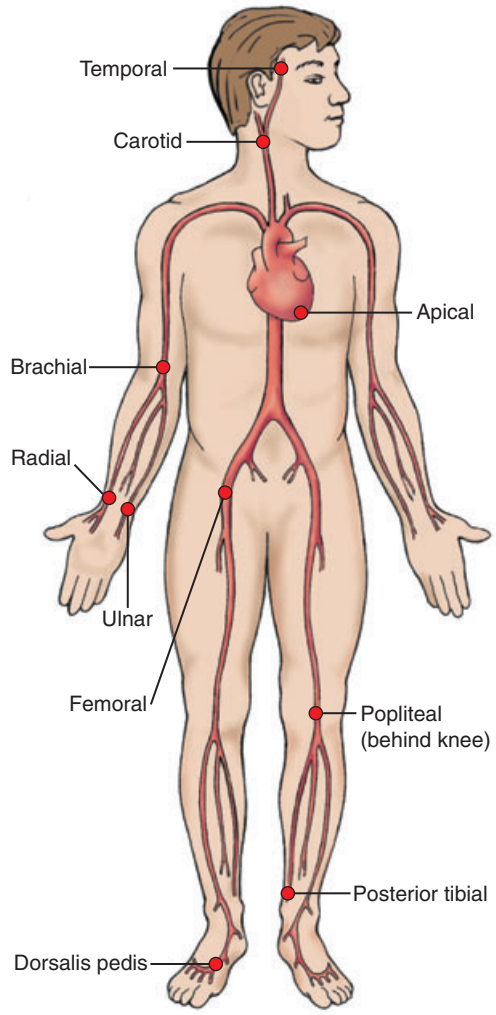


Figure 19-10. Pulse sites. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

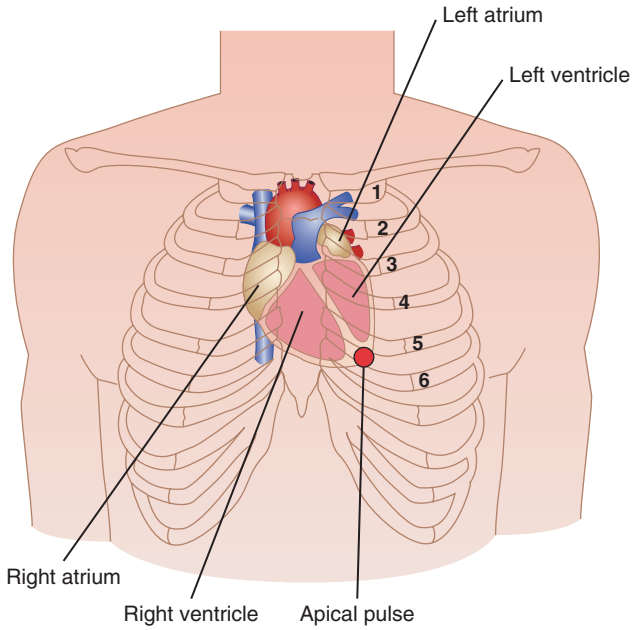


Figure 19-11. The apical pulse is found over the apex of the heart, which is located in the fifth intercostal space at the junction of the left midclavicular line. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

pulse when the radial pulse is inaccessible. It is also an easy access site to assess pulse in children.

Carotid The carotid pulse is located on the anterior side of the neck, slightly to one side of the midline, and is the best site to find a pulse quickly. This site is used to measure pulse in children and adults during cardiac arrest. The carotid site also is commonly used by individuals to monitor pulse during exercise.

Femoral The femoral pulse is in the middle of the groin. This site is used to measure pulse in infants and children and in adults during cardiac arrest and to assess the status of the circulation to the lower leg.

Popliteal The popliteal pulse is at the back of the knee and is detected most easily when the knee is slightly flexed. This site is used to measure blood pressure when the brachial pulse is inaccessible and to assess the status of the circulation to the lower leg.

Posterior Tibial The posterior tibial pulse is located on the inner aspect of the ankle just posterior to the ankle bone. This site is used to assess the status of circulation to the foot.

Dorsalis Pedis The dorsalis pedis pulse is located on the upper surface of the foot, between the first and second metatarsal bones. This site is used to assess the status of circulation to the foot.

Assessment of Pulse

The purpose of measuring pulse is to establish the patient's baseline pulse rate and to assess the pulse rate after special procedures, medications, or disease processes that affect heart functioning. Pulse is measured using palpation at all of the pulse sites except the apical site.

Memories *from* Externship

Sergio Martinez: One experience that really stands out in my memory occurred during my externship at a family practice medical office. I needed to take the blood pressure of a small 6-year-old boy. After I put the cuff on his arm, his eyes started filling up with tears. I stopped, removed the cuff, and asked him if something was wrong. He said he was afraid that, when I started squeezing that thing around his arm, his hand would fall off. I sat down next to him, spent some time talking with him, and reassured him that his hand would be perfectly fine and would not fall off. I put the cuff on my arm and pumped it up to show him that he would be safe. He then agreed to let me take his blood pressure. After I took his blood pressure, he wiggled his hand, gave me a big smile, and said that it didn't hurt at all. That situation made me realize that children may have a lot of fears about what might happen to them at the medical office. Since that experience, I always take the time to explain procedures to children before I perform them. ■

Prepare for Success

A pulse is palpated by applying moderate pressure with the sensitive pads located on the tips of the three middle fingers. The pulse should not be taken with the thumb because the thumb has a pulse of its own. This could result in a measurement of the medical assistant's pulse rather than the patient's pulse. Excessive pressure should not be applied when measuring pulse because it could obliterate, or close off, the pulse. It may not be possible to detect the pulse if too little pressure is applied, however. An accurate assessment of pulse includes a determination of the pulse rate, the pulse rhythm, and the pulse volume.

Pulse Rate

The pulse rate is the number of heart pulsations or heartbeats that occur in 1 minute; therefore, pulse rate is measured in beats per minute. Normal pulse rates vary widely in the various age groups, as shown in Table 19-4. For a healthy adult, the normal resting pulse rate ranges from 60 to 100 beats per minute, with the average falling between 70 and 80 beats per minute.

An abnormally fast heart rate of more than 100 beats per minute is known as **tachycardia.** Tachycardia may indicate disease states, such as hemorrhaging or heart disease. An individual's pulse rate may normally exceed 100 beats per minute, however, during vigorous exercise or during strong emotional states.

Bradycardia is an abnormally slow heart rate, less than 60 beats per minute. A pulse rate less than 60 beats per minute may occur normally during sleep. Trained athletes often have low pulse rates. If a patient exhibits tachycardia or bradycardia during radial pulse measurement, the apical pulse should also be measured.

Pulse Rhythm and Volume

In addition to measuring the pulse rate, the medical assistant should determine the rhythm and volume of the pulse. The **pulse rhythm** denotes the time interval between heartbeats; a normal rhythm has the same time interval between beats. Any irregularity in the heart's rhythm is known as a **dysrhythmia** (also termed *arrhythmia*) and is characterized by unequal or irregular intervals between the heartbeats. If a dysrhythmia is present, the physician may order one or more of the following: an apical-radial pulse, an electrocardiogram, or Holter monitoring.

An *apical-radial pulse* is performed to determine whether a pulse deficit is present. Taking an apical-radial pulse involves measuring the apical pulse at the same time as the radial pulse for a duration of 1 full minute. A *pulse deficit* exists when the radial pulse rate is less than the apical pulse rate. If one medical assistant measures an apical pulse rate of 88 beats per minute, and another medical assistant simultaneously measures a radial pulse rate of 76 beats per minute, this results in a pulse deficit of 12 beats. A pulse deficit means that not all of the heartbeats are reaching the peripheral arteries. A pulse deficit is caused by an inefficient contraction of the heart that is not strong enough to transmit a pulse wave to the peripheral pulse site. A pulse deficit frequently occurs with atrial fibrillation, which is a type of dysrhythmia.

The **pulse volume** refers to the strength of the heartbeat. The amount of blood pumped into the aorta by each contraction of the left ventricle should remain constant, making the pulse feel strong and full. If the blood volume decreases, the pulse feels weak and may be difficult to detect. This type of pulse is usually accompanied by a fast heart rate and is described as a **thready pulse.** An increase in the blood volume results in a pulse that feels extremely strong and full, known as a **bounding pulse.**

Any abnormalities in the rhythm or volume of the pulse should be recorded accurately in the patient's chart by the medical assistant. A pulse that has a normal rhythm and volume is recorded as being regular and strong.

RESPIRATION

Mechanism of Respiration

The purpose of respiration is to provide for the exchange of oxygen and carbon dioxide between the atmosphere and the blood. Oxygen is taken into the body to be used for vital body processes, and carbon dioxide is given off as a waste product.

Each respiration is divided into two phases: **inhalation** and **exhalation** (Figure 19-12). During inhalation, or inspiration, the diaphragm descends and the lungs expand, causing air containing oxygen to move from the atmosphere into the lungs. Exhalation, or expiration, involves the removal of carbon dioxide from the body. The diaphragm ascends, and the lungs return to their original state so that air containing carbon dioxide is expelled. One complete respiration is composed of one inhalation and one exhalation.

Respiration can be classified as *external* or *internal.* External respiration involves the exchange of oxygen and carbon dioxide between the **alveolus** (thin-walled sacs) of the lungs and the blood (Figure 19-13). The blood, located in small capillaries, comes in contact with the alveoli, picks up oxygen, and carries it to the cells of the body. At this point, the oxygen is given off to the cells and carbon dioxide is picked up by the blood to be transported as a waste product to the lungs. The exchange of oxygen and carbon dioxide between the body cells and the blood is known as *internal respiration.*

Control of Respiration

The medulla oblongata, located in the brain, is the control center for involuntary respiration. A buildup of carbon dioxide in the blood sends a message to the medulla, which triggers respiration to occur automatically.

To a certain extent, respiration is also under voluntary control. An individual can control respiration during activities such as singing, laughing, talking, eating, and crying. Voluntary respiration is ultimately under the control of the medulla oblongata. The breath can be held for only a certain length of time, after which carbon dioxide begins to build

PATIENT TEACHING Aerobic Exercise

Answer questions patients have about aerobic exercise.

What is aerobic exercise?

Aerobic exercise increases, sustains, and decreases your pulse over time. Aerobic exercise is accomplished through a steady, nonstop activity, such as walking, jogging, cycling, or swimming. Each workout should include a warm-up and cool-down period of at least 5 minutes each. This is to prevent muscle or joint injuries.

What are the benefits of an aerobic exercise program?

The benefits of an aerobic exercise program include strengthening of the heart, a slower resting pulse rate, reduction of stress, increased energy, lowering of body fat, a decrease of "bad" (low-density lipoprotein) cholesterol, and an increase of "good" (high-density lipoprotein) cholesterol. The key to a safe and effective aerobic exercise program is the target heart rate (THR).

What is target heart rate?

Your THR is a safe and effective exercise pulse range that indicates you are exercising at the right level for your age and for what you are trying to accomplish with exercise. Exercising at a level below your THR does little to promote fitness; exercising at a level above your THR may not be safe.

How do I determine my target heart rate?

The following formula is used to determine your THR:

1. Subtract your age from 220 to determine your maximum heart rate (MHR), which is the fastest your heart can beat safely for your age. The MHR of a 40-year-old person is calculated as follows:

   220 – 40 years old = 180 (MHR)

2. Determine the lower end of your THR range by multiplying your MHR by 0.6. For our example:

   180 × 0.60 = 180 (low end of THR)

3. Determine the upper end of your THR range by multiplying your MHR by 0.8. For our example:

   180 × 0.80 = 144 (upper end of THR)

Always exercise within your THR range. The 40-year-old person in our example should exercise with a THR between 108 and 144.

How often should aerobic exercise be performed?

A report from the American Cancer Society recommends that adults spend at least 30 minutes or more, at least 5 days a week, in moderately intense exercise to obtain the maximum benefits for heart health. Researchers say that this exercise recommendation is based on studies of the amount of energy burned by people who maintain a healthy weight. They stress that there are many ways to accomplish this goal, such as through playing with your children, doing housework, gardening, mowing the grass, walking the dog, bicycling, golfing, swimming, and other day-to-day activities. The American Cancer Society further recommends that children and adolescents engage in at least 60 minutes per day of moderate to vigorous physical activity at least 5 days a week. ■

What Would You Do? What Would You *Not* Do?

Case Study 2

Alex Jacoby is 18 years old and a senior in high school. He comes to the office complaining of severe pain in his left shoulder. Alex is an outstanding competitive swimmer and is currently ranked first in the state in the 100-yard butterfly. Alex has a big meet coming up and must do well because he has a chance of getting an athletic scholarship to the University of Florida. He says he thinks he can take 2 seconds off his best time at this meet and he does not want anything to interfere with that. Alex wants the physician to do whatever he can to make his shoulder better and thinks that a steroid injection and OxyContin might be the answer. His vital signs are as follows: temperature 98.5°F, pulse 48 beats/min, respirations 12 breaths/min, and blood pressure 108/68 mm Hg. Alex asks why his pulse is so slow and wants to know if there is any medication he can take to make it faster. ■

up in the body, resulting in a stimulus to the medulla that causes respiration to occur involuntarily. Small children may voluntarily hold their breath during a temper tantrum. A parent who does not understand the principles of respiration may be concerned that the child would cease breathing. The medical assistant should be able to explain that involuntary respiration would eventually occur and the child would resume breathing.

Assessment of Respiration

Because an individual can control his or her respiration, the medical assistant should measure respirations without the patient's knowledge. Patients may change their respiratory rate unintentionally if they are aware that they are being measured. An ideal time to measure respiration is after the pulse is taken. Procedure 19-6 outlines the procedures for taking pulse and respiration in one continuous procedure.

Respiratory Rate

The respiratory rate of a normal healthy adult ranges from 12 to 20 respirations per minute. With most adults, there is a ratio of one respiration for every four pulse beats. If the

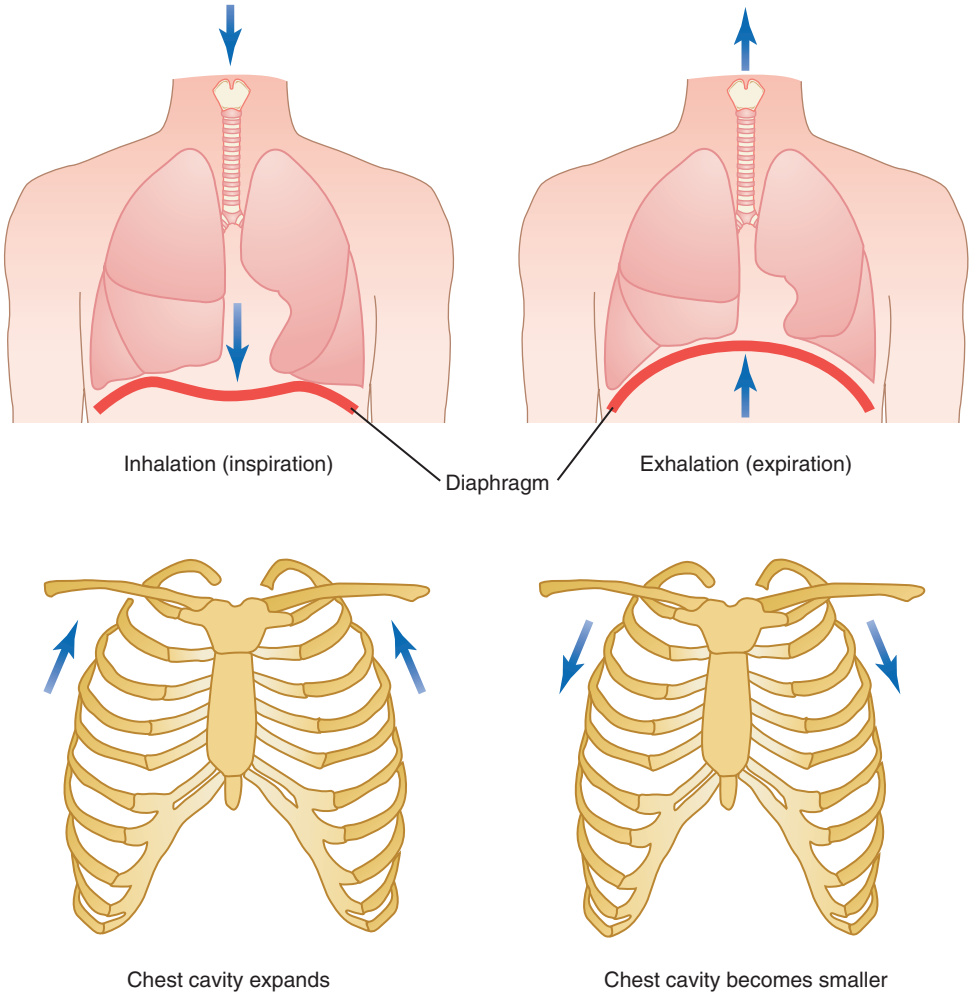


Figure 19-12. Inhalation and exhalation. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

respiratory rate is 18, the pulse rate would be approximately 72 beats per minute. An abnormal increase in the respiratory rate of more than 20 respirations per minute is referred to as **tachypnea.** An abnormal decrease in the respiratory rate of less than 12 respirations per minute is known as **bradypnea.** When measuring the respiratory rate, the medical assistant should take into consideration the following factors:

1. **Age.** As age increases, the respiratory rate decreases. The respiratory rate of a child would be expected to be faster than that of an adult. Table 19-5 provides a chart of the respiratory rates for the various age groups.
2. **Physical activity.** Physical activity increases the respiratory rate temporarily.
3. **Emotional states.** Strong emotional states temporarily increase the respiratory rate.
4. **Fever.** A patient with a fever has an increased respiratory rate. One way that heat is lost from the body is through the lungs; a fever causes an increased respiratory rate as the body tries to rid itself of the excess heat.

Table 19-5 Respiratory Rates of Various Age Groups

Age Group	Average Respiratory Range (breaths/min)	Respiratory Average (breaths/min)
Infant (birth to 1 yr)	30-40	35
Toddler (1-3 yr)	23-35	30
Preschool child (3-6 yr)	20-30	25
School-age child (6-12 yr)	18-26	22
Adolescent (12-18 yr)	12-20	16
Adult (after 18th yr)	12-20	16

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.

5. **Medications.** Certain medications increase the respiratory rate, and others decrease it. If the medical assistant is unsure of what effect a particular drug may have on the respiratory rate, he or she should consult a drug reference, such as the *Physician's Desk Reference* (PDR).

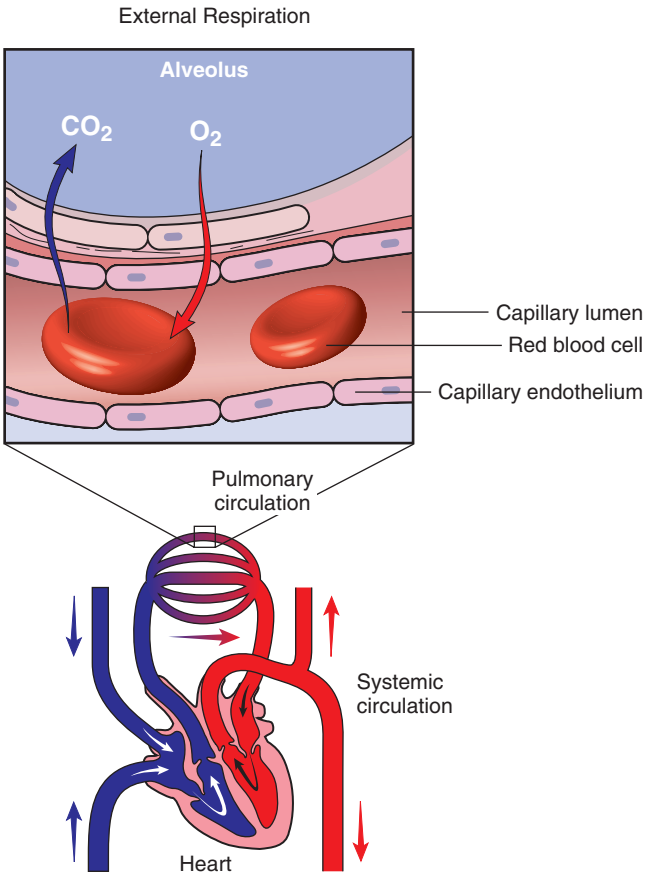


Figure 19-13. Exchange of oxygen and carbon dioxide between the alveoli of the lungs and the blood. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Rhythm and Depth of Respiration

The *rhythm* and *depth* should be noted when measuring respiration. Normally the rhythm should be even and regular, and the pauses between inhalation and exhalation should be equal. The depth of respiration indicates the amount of air that is inhaled or exhaled during the process of breathing. Respiratory depth is generally described as normal, deep, or shallow and is determined by observing the amount of movement of the chest. For normal respirations, the depth of each respiration in a resting state is approximately the same. Deep respirations are those in which a large volume of air is inhaled and exhaled, whereas shallow respirations involve the exchange of a small volume of air. Normal respiration is referred to as **eupnea.** The rate is approximately 12 to 20 respirations per minute, the rhythm is even and regular, and the depth is normal.

Hyperpnea is an abnormal increase in the rate and depth of the respirations. A patient with hyperpnea exhibits a deep, rapid, and labored respiration. Hyperpnea occurs normally with exercise and abnormally with pain and fever. It also can occur with any condition in which the supply of oxygen is inadequate, such as heart disease and lung disease.

Hyperventilation is an abnormally fast and deep type of breathing that is usually associated with acute anxiety conditions, such as panic attacks. An individual who is hyperventilating is "overbreathing," which usually causes dizziness and weakness.

Hypopnea is a condition in which a patient's respiration exhibits an abnormal decrease in the rate and depth. The depth is approximately half that of normal respiration. Hypopnea often occurs in individuals with sleep disorders.

PATIENT TEACHING Chronic Obstructive Pulmonary Disease

Answer questions that patients have about chronic obstructive pulmonary disease (COPD).

What is COPD?

COPD is a chronic airway obstruction that results from emphysema, chronic bronchitis, or asthma, or any combination of these conditions. COPD is a chronic, debilitating, irreversible, and sometimes fatal disease.

How many people have COPD?

COPD affects an estimated 16 million Americans, and its incidence is increasing. It is the fourth leading cause of death in the United States behind heart disease, cancer, and stroke. Although COPD is much more common in men than in women, the greatest increase of death rates is occurring in women.

What causes COPD?

Cigarette smoking for a period of many years is the leading cause of COPD. Other causes include air pollution and occupational exposure to irritating inhalants, such as noxious dusts, fumes, and vapors.

What types of tests might the physician order?

Respiratory tests to diagnose COPD include various types of pulmonary function tests. Examples of pulmonary function tests are spirometry, lung volumes, diffusion capacity, arterial blood gas studies, pulse oximetry, and cardiopulmonary exercise tests.

What treatment might the physician prescribe?

Treatment is focused on improving breathing difficulties and may include bronchodilator drug therapy, breathing exercises, and oxygen therapy.

1. Encourage patients with COPD to comply with therapy prescribed by the physician.
2. Provide the patient with information about smoking, asthma, emphysema, and chronic bronchitis. Educational materials are available from the American Lung Association, American Heart Association, and American Cancer Society. ■

Color of the Patient

The patient's color should be observed while the respiration is being measured. A reduction in the oxygen supply to the tissues (hypoxia) results in a condition known as **cyanosis,** which causes a bluish discoloration of the skin and mucous membranes. Cyanosis is first observed in the nail beds and lips because in these areas the blood vessels lie close to the surface of the skin. Cyanosis typically occurs in patients with advanced emphysema and in patients during cardiac arrest.

Apnea is a temporary absence of respirations. Some individuals experience apnea during sleep; this condition is known as *sleep apnea.* Apnea can be a serious condition if the individual's breathing ceases for more than 4 to 6 minutes because brain damage or death could occur.

Respiratory Abnormalities

A patient who is having difficulty breathing or shortness of breath has a condition known as **dyspnea.** Dyspnea may occur normally during vigorous physical exertion and abnormally in patients with asthma and emphysema. A patient with dyspnea may find it easier to breathe while in a sitting or standing position. This state is called **orthopnea** and occurs with disorders of the heart and lungs, such as asthma, emphysema, pneumonia, and congestive heart failure.

Breath Sounds

Breath sounds are caused by air moving through the respiratory tract. Normal breath sounds are quiet and barely audible. Abnormal breath sounds are referred to as **adventitious sounds** and generally signify the presence of a respiratory disorder. The cause and character of abnormal breath sounds are presented in Table 19-6.

PULSE OXIMETRY

Pulse oximetry is a painless and noninvasive procedure used to measure the oxygen saturation of hemoglobin in arterial blood. Hemoglobin is a complex compound found in red blood cells that functions in transporting oxygen in the body. Pulse oximetry provides the physician with information on a patient's cardiorespiratory status—in particular, the amount of oxygen being delivered to the tissues of the body. The procedure for performing pulse oximetry is presented in Procedure 19-8.

A **pulse oximeter** is the device used to measure and display the oxygen saturation of the blood. It is a computerized device that consists of a two-sided, cliplike probe connected by a cable to a monitor (Figure 19-14). A pulse oximeter also measures the patient's pulse rate in beats per minute. A constant-pitched audible beep is emitted with each pulse beat.

Assessment of Oxygen Saturation

Mechanism of Action

The probe of the pulse oximeter must be attached to a peripheral pulsating capillary bed, such as the tip of a finger. One side of the probe contains a *light-emitting diode* (LED) that transmits infrared light and red light through the patient's tissues to a light detector located on the other side of the probe, known as the *photodetector* (Figure 19-15).

Hemoglobin that is bright red in color has a high oxygen content *(oxygen-rich)* and absorbs more of the infrared light emitted by the LED. Hemoglobin that is dark red in color is low in oxygen *(oxygen-poor)* and absorbs more of the red

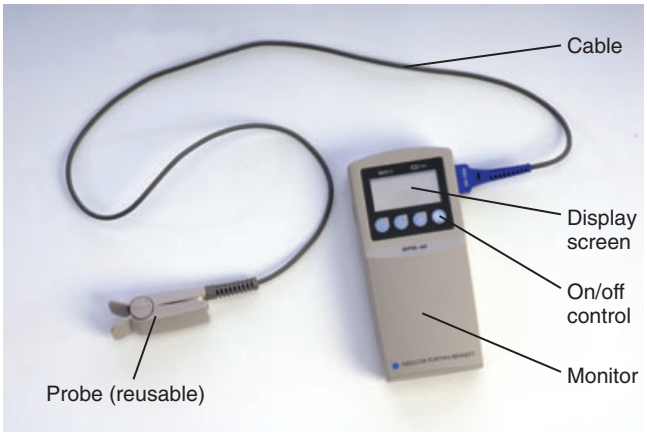


Figure 19-14. Pulse oximeter. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Table 19-6 Abnormal Breath Sounds

Type	Cause	Character
Crackles* (rales)	Air moving through airways that contain fluid	Dry or wet intermittent sounds that vary in pitch (this sound can be duplicated by rubbing hair together next to ear)
Rhonchi*	Thick secretions, tumors, or spasms that partially obstruct air flow through large upper airways	Deep, low-pitched, rumbling sound more audible during expiration
Wheezes	Severely narrowed airways caused by partial obstruction in smaller bronchi and bronchioles; common symptom of asthma	Continuous, high-pitched, whistling musical sounds heard during inspiration and expiration
Pleural friction rub*	Inflamed pleura rubbing together	High, grating sound similar to rubbing leather pieces together; heard on inspiration and expiration

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.
*Audible only through a stethoscope.

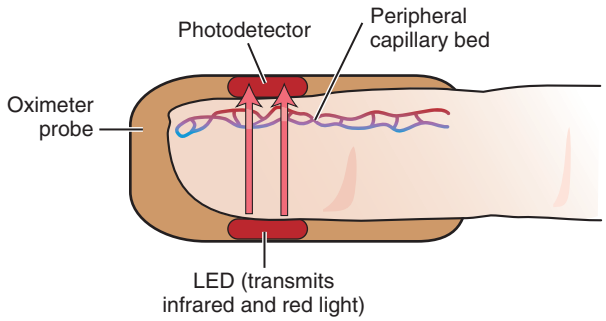


Figure 19-15. The probe of the pulse oximeter is attached to a peripheral capillary bed in the fingertip. The LED transmits light through the capillary bed to a light detector (photodetector) located on the other side of the probe to measure the oxygen saturation of hemoglobin. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

light. The oximeter's computer compares and calculates the light transmitted from the oxygen-rich hemoglobin and the oxygen-poor hemoglobin and, from this ratio, is able to determine the oxygen saturation of the patient's hemoglobin. This measurement is converted to a percentage and displayed as a digital readout on the screen of the monitor. Because the pulse oximeter measures the oxygen saturation of peripheral capillaries, the abbreviation **SpO_2** *(saturation of peripheral oxygen)* is used to record the reading.

A more complete but invasive measurement of oxygen saturation is arterial blood gas analysis, which requires drawing a blood specimen from an artery. The abbreviation for this type of arterial oxygen saturation measurement is **SaO_2** *(saturation of arterial oxygen).*

Interpretation of Results

The pulse oximetry reading represents the percentage of hemoglobin that is saturated (filled) with oxygen. Each molecule of hemoglobin can carry four oxygen molecules. If 100 molecules of hemoglobin were fully saturated with oxygen, they would be carrying 400 molecules of oxygen and the oxygen saturation reading would be 100%. If these same 100 molecules of hemoglobin were carrying only 360 molecules of oxygen, however, the oxygen saturation reading would be 90%. The more hemoglobin that is saturated with oxygen, the higher the oxygen saturation of the blood.

The oxygen saturation level of most healthy individuals is 95% to 99%. Because the air we breathe is only 21% saturated with oxygen, it is unusual for an individual's hemoglobin to be fully or 100% saturated with oxygen. Patients on supplemental oxygen sometimes have a reading of 100%, however.

An oxygen saturation level less than 95% typically results in an inadequate amount of oxygen reaching the tissues of the body, although patients with chronic pulmonary disease are sometimes able to tolerate lower saturation levels. Respiratory failure, resulting in tissue damage, usually occurs when the oxygen saturation decreases to a level between 85% and 90%. Cyanosis typically appears when an individual's oxygen saturation reaches a level of 75%, and an oxygen saturation less than 70% is life-threatening.

A decrease in the oxygen saturation of the blood (less than 95%) is known as **hypoxemia.** Hypoxemia can lead to a more serious condition known as hypoxia. **Hypoxia** is defined as a reduction in the oxygen supply to the tissues of the body, and if not treated, it can lead to tissue damage and death. The first symptoms of hypoxia include headache, mental confusion, nausea, dizziness, shortness of breath, and tachycardia. The tissues most sensitive to hypoxia are the brain, heart, pulmonary vessels, and liver.

Purpose of Pulse Oximetry

In the medical office, pulse oximetry is often performed on patients complaining of respiratory problems (e.g., dyspnea). A decreased pulse oximetry reading (along with further testing and the patient's clinical signs and symptoms) assists the physician in proper diagnosis and treatment, which may include drug therapy and oxygen therapy.

Conditions that can cause a decreased SpO_2 value (hypoxemia) include the following:

- Acute pulmonary disease (e.g., pneumonia)
- Chronic pulmonary disease (e.g., emphysema, asthma, bronchitis)
- Cardiac problems (e.g., congestive heart failure, coronary artery disease)

In addition to assisting the physician in diagnosing a patient's condition, pulse oximetry is used to assess the following:

- Effectiveness of oxygen therapy
- Patient's tolerance to activity
- Effectiveness of treatment (e.g., bronchodilators)
- Patient's tolerance to analgesia and sedation

In the medical office, pulse oximetry is most often used as a "spot-check" measurement—in other words, as a single measurement of oxygen saturation. Occasionally, pulse oximetry may be used for the short-term *continuous monitoring* of a patient in the office for the following: to monitor a patient experiencing an asthmatic attack or to monitor a sedated patient during minor office surgery.

Components of the Pulse Oximeter

Most medical offices use a handheld pulse oximeter (see Figure 19-14), which is portable, lightweight, and battery operated. This is in contrast to a stand-alone oximeter, which is more apt to be used in a hospital setting for the continuous bedside monitoring of a patient's oxygen saturation level. A pulse oximeter not only measures oxygen saturation, but also measures the pulse rate in beats per minute. The two main parts of the pulse oximeter, the monitor and probe, are described in more detail next.

Monitor

The monitor contains controls, indicators, and displays (Figure 19-16). These may vary slightly depending on the brand of oximeter. Those that are found on most handheld pulse oximeters include the following:

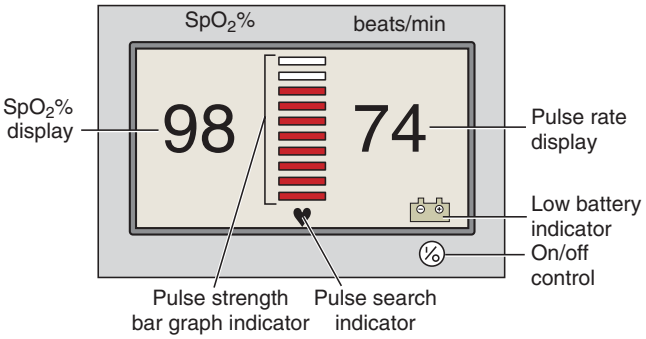


Figure 19-16. Pulse oximeter monitor: controls, indicators, and displays. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

1. **On/off control.** Turns the oximeter on and off.
2. **SpO_2% display.** A digital display of the patient's oxygen saturation expressed as a percent. This number is updated with each pulse beat.
3. **Pulse rate display.** This display indicates the patient's pulse rate in beats per minute. This number is updated with each pulse beat. Most oximeters emit a constant-pitched audible beep with each pulse beat.
4. **Pulse strength bar graph indicator.** This indicator provides a visual display of the patient's pulse strength at the probe placement site. The pulse strength indicator consists of a segmented display of bars. The pulse strength indicator "sweeps" with each pulse beat, and the stronger the pulse, the more segments that light up on the bar graph.
5. **Pulse search indicator.** This indicator lights when the oximeter is searching for the patient's pulse.
6. **Adjustable volume control.** This control is used to adjust the beep that sounds with each pulse beat. In most oximeters, the settings are high, low, and off.
7. **Low battery indicator.** This indicator is used to warn that the battery is getting low. The indicator lights up and the monitor sounds an alarm when approximately 30 minutes of battery use remain.
8. **Alarm messages.** Alarm messages indicate a problem or condition that may affect the reading. Alarm messages must not be ignored and must be corrected before continuing.

When the pulse oximeter is turned on, it automatically performs a power-on self-test (POST), which takes approximately 3 to 5 seconds. During the POST, the oximeter checks its internal systems to ensure they are functioning properly. If the oximeter detects a problem, an alarm sounds and the monitor displays an error code. If this occurs, the medical assistant should refer to the troubleshooting section of the user's manual for interpretation of the error code and the necessary action that should be taken.

When the POST is completed, the oximeter begins searching for a pulse. During this time, the pulse search indicator lights up. It takes several seconds for the oximeter to locate a pulse and to calculate and display the SpO_2 reading. If the oximeter is unable to detect a pulse, or if the pulse is too weak to provide the necessary data needed to calculate oxygen saturation, the oximeter is unable to make a measurement. In this case, an alarm sounds and the oximeter may automatically shut off. If this occurs, the medical assistant should reposition the probe or move the probe to another finger and perform the procedure again.

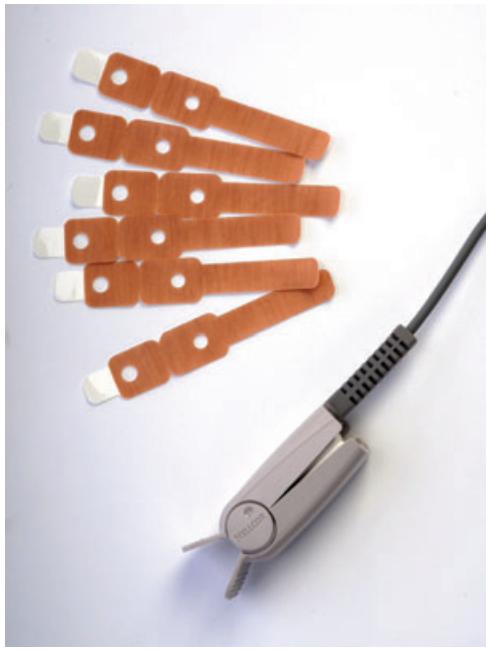


Figure 19-17. Disposable *(top)* and reusable *(bottom)* probes for the pulse oximeter. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Probe

The probe of the pulse oximeter may be reusable or disposable (Figure 19-17). Most offices use reusable clip-on probes. Reusable probes are convenient to use and easy to apply, but they are more susceptible to inaccurate readings owing to patient movement. Reusable probes must be cleaned and disinfected after each use. Disposable probes are expensive to use and are generally employed for the long-term monitoring of a patient's oxygen saturation level in a hospital setting. Disposable probes are made of an adhesive, bandage-like material and are discarded after use.

It is important to handle reusable probes carefully. Hitting a probe against a hard object or dropping it may damage it. It is also important to use the probe designed for the pulse oximeter being used. Mixing probes from different manufacturers can result in an inaccurate reading.

The probe must be attached to the patient at a peripheral site that is highly vascular and where the skin is thin. The most common site to apply a probe is the tip of a finger (Figure 19-18); other acceptable sites include the toe and earlobe. A specially designed probe is available for application to the earlobe; it is smaller than a finger probe and has a curved ear attachment to hold it in place.

A cable connects the probe to the monitor. The probe may be permanently attached to the cable, or it may be a separate device that requires connection to the cable. The pulse oximeter monitor should never be lifted or carried by the cable because this could damage the cable connections

Figure 19-18. Applying a probe at the tip of a finger. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

or cause the cable to disconnect from the monitor and possibly drop on the floor or fall on the patient.

Factors Affecting Pulse Oximetry

Although pulse oximetry is an easy procedure to perform, the medical assistant must be aware of certain factors that may interfere with an accurate reading. These factors are listed along with guidelines for correcting or preventing them.

1. **Incorrect positioning of the probe.** As previously discussed, the oximeter probe consists of two parts: an LED and a photodetector. Because light is transmitted from the LED through the tissues to the photodetector, it is important that these two components be aligned directly opposite to each other during the measurement. In most cases, this automatically occurs when the clip-on probe is applied. Proper alignment of the probe may be impossible, however, with patients who have small fingers (e.g., a thin patient or a child) or patients who have large fingers (e.g., an obese patient). To obtain an accurate reading, another site must be used, such as the earlobe. In addition, pediatric probes are available for use with thin patients or children.
2. **Fingernail polish or artificial nails.** A dark, opaque coating on the fingernail may result in a falsely low reading. This is because the coating interferes with proper light transmission through the finger. The darker the coating, the more likely that the SpO_2 reading will be affected. Blue, black, and green nail polishes tend to cause the most problems. If the patient is wearing fingernail polish, it should be removed with acetone or fingernail polish remover. If the patient has artificial fingernails, another site should be used to take the measurement, such as the earlobe or toe. Oil, dirt, and grime on the fingertip can also interfere with proper light transmission. If the patient's fingertip is dirty, cleanse the site with soap and water and allow it to dry. Areas with bruises, burns, stains, or tattoos should be avoided as a probe placement site. Darkly pigmented skin and jaundice do not usually affect the ability of the oximeter to obtain an accurate reading.
3. **Poor peripheral blood flow.** A pulse oximeter works best when there is a good strong pulse in the finger to which the probe is applied. Poor peripheral blood flow may cause the pulse to be so weak that the oximeter cannot obtain a reading. Conditions resulting in poor blood flow include peripheral vascular disease, vasoconstrictor medications, severe hypotension, and hypothermia. In these situations, the medical assistant should try using the earlobe because it is less affected by decreased blood flow. Sometimes patients with cold fingers (but who are not hypothermic) may have enough constriction of the peripheral capillaries that it interferes with obtaining a reading. To solve this problem, the medical assistant should ask the patient to warm his or her fingers by rubbing the hands together. The probe should never be attached to the finger of an arm to which an automatic blood pressure cuff is applied because blood flow to the finger would be cut off when the cuff inflates, resulting in loss of the pulse signal.
4. **Ambient (surrounding) light.** Ambient light shining directly on the probe, such as bright fluorescent light, direct sunlight, or an overhead examination light, may result in an inaccurate reading. This is because some of the ambient light may be picked up by the probe's photodetector and alter the reading. This problem can be corrected by one of the following: turning off the light, moving the patient's hand away from the light source, or covering the probe with an opaque material such as a washcloth.
5. **Patient movement.** Patient movement is a common cause of an inaccurate reading. Motion affects the ability of the light to travel from the LED to the photodetector and prevents the probe from picking up the pulse signal. To avoid this problem, it is important that the medical assistant instruct the patient to remain still and not move during the procedure. Occasionally, patient movement cannot be eliminated, such as when the patient has tremors of the hands. In these instances, the oxygen saturation level should be measured at a site that is less affected by motion, such as the toe or earlobe.

Pulse Oximeter Care and Maintenance

The pulse oximeter monitor and cable should be cleaned periodically using a damp cloth slightly dampened with a solution of warm water and a disinfectant cleaner. The medical assistant should make sure that the cloth is not too wet to prevent the solution from running into the monitor, which could damage the internal components. The probe should be cleaned periodically with a soft cloth moistened with warm water and a disinfectant cleaner. Cleaning the probe removes dirt and grime that could interfere with proper light transmission, leading to an inaccurate reading. The probe also should be disinfected after each use by wiping it thoroughly with an antiseptic wipe and allowing it

to dry. The probe should never be soaked or immersed in a liquid solution because this would damage it. The probe is heat-sensitive and cannot be autoclaved. The pulse oximeter should be stored at room temperature in a dry environment.

Text continued on p. 361

PROCEDURE 19-6 Measuring Pulse and Respiration

Outcome Measure pulse and respiration.

Equipment/Supplies

- Watch with a second hand

1. **Procedural Step.** Sanitize your hands. Greet the patient and introduce yourself. Identify the patient and explain the procedure. Observe the patient for any signs that might affect the pulse or respiratory rate.
   Principle. Pulse rate can vary according to the factors listed on p. 387.
2. **Procedural Step.** Have the patient sit down. Position the patient's arm in a comfortable position. The forearm should be slightly flexed to relax the muscles and tendons over the pulse site.
   Principle. Relaxed muscles and tendons over the pulse site make it easier to palpate the pulse.
3. **Procedural Step.** Place your three middle fingertips over the radial pulse site. Never use your thumb to take a pulse. The radial pulse is located in a groove on the inner aspect of the wrist just below the thumb.
   Principle. The thumb has a pulse of its own; using the thumb results in a measurement of the medical assistant's pulse and not the patient's pulse.
4. **Procedural Step.** Apply moderate, gentle pressure directly over the site until you feel the pulse. If you cannot feel the pulse, it may be caused by:
   a. Incorrect location of the radial pulse: Move your fingers to a slightly different location in the groove of the wrist until you feel the pulse.
   b. Applying too much pressure or not enough pressure: Vary the depth of your hold until you can feel the pulse.
   Principle. A normal pulse can be felt with moderate pressure. The pulse cannot be felt if not enough pressure is applied, whereas too much pressure applied to the radial artery closes it off, and no pulse is felt.
5. **Procedural Step.** Count the pulse for 30 seconds and make a mental note of this number. Note the rhythm and volume of the pulse. If abnormalities occur in the rhythm or volume, count the pulse for 1 full minute.
   Principle. A longer time ensures an accurate assessment of abnormalities.

Place the three middle fingers over the radial pulse site. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Count the pulse for 30 seconds. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

6. **Procedural Step.** After taking the pulse, continue to hold three fingers on the patient's wrist with the same amount of pressure, and measure the respirations. This helps to ensure that the patient is unaware that respirations are being monitored.

Principle. If the patient is aware that respiration is being measured, the breathing may change.

Count the number of respirations for 30 seconds. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

7. **Procedural Step.** Observe the rise and fall of the patient's chest as the patient inhales and exhales.

Principle. One complete respiration includes one inhalation and one exhalation.

8. **Procedural Step.** Count the number of respirations for 30 seconds, and make a mental note of this number; note the rhythm and depth of the respirations. Also observe the patient's color. If abnormalities occur in the rhythm or depth, count the respiratory rate for 1 full minute.
9. **Procedural Step.** Sanitize your hands, and chart the results. If you counted the pulse and respirations for 30 seconds, multiply each of the numbers counted by 2. This will give you the pulse rate and respiratory rate for 1 full minute. Include the date; time; pulse rate, rhythm, and volume; and respiratory rate, rhythm, and depth.

CHARTING EXAMPLE

Date	
10/15/10	2:30 p.m. P: 74. Reg and strong. R: 18.
	Even and reg. ——— S. Martinez, RMA

see DVD

PROCEDURE 19-7 Measuring Apical Pulse

Outcome Measure apical pulse.

Equipment/Supplies

- Watch with a second hand
- Stethoscope
- Antiseptic wipe

1. **Procedural Step.** Sanitize your hands. Greet the patient and introduce yourself. Identify the patient and explain the procedure. Observe the patient for any signs that might increase or decrease the pulse rate.
2. **Procedural Step.** Assemble the equipment. If the stethoscope's chest piece consists of a diaphragm and a bell, rotate the chest piece to the bell position. Clean the earpieces and chest piece of the stethoscope with an antiseptic wipe.
   Principle. The bell position allows better auscultation of heart sounds. Cleaning the earpieces helps prevent the transmission of microorganisms.
3. **Procedural Step.** Ask the patient to unbutton or remove his or her shirt. Have the patient sit or lie down (supine).
   Principle. A sitting or supine position allows access to the apex of the heart.
4. **Procedural Step.** Warm the chest piece of the stethoscope with your hands. Insert the earpieces of the stethoscope into your ears, with the earpieces directed slightly forward, and place the chest piece over the apex of the patient's heart. The apex of the heart is located in the fifth intercostal space at the junction of the left midclavicular line.
   Principle. Warming the chest piece reduces the discomfort of having a cold object placed on the chest. In addition, a cold chest piece could startle the patient, resulting in an increase in the pulse rate. The earpieces should be directed forward to follow the direction of the ear canal, which facilitates hearing.

Continued

PROCEDURE 19-7 Measuring Apical Pulse—cont'd

Insert the earpieces into your ears with the earpieces directed slightly forward. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Count the number of beats for 30 seconds, and multiply by 2. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

5. **Procedural Step.** Listen for the heartbeat, and count the number of beats for 30 seconds (and multiply by 2) if the rhythm and volume are normal or if the apical pulse is being taken on an infant or child. If abnormalities occur in the rhythm or volume, count the pulse for 1 full minute. You will hear a "lubb-dupp" sound through the stethoscope. This sound is the closing of the heart's valves. Each "lubb-dupp" is counted as one beat.
6. **Procedural Step.** Sanitize your hands, and chart the results. Include the date, time, and the apical pulse rate, rhythm, and volume.
7. **Procedural Step.** Clean the earpieces and the chest piece of the stethoscope with an antiseptic wipe.

CHARTING EXAMPLE

Date	
10/15/10	10:15 a.m. AP: 68. Reg and strong.———
	——————— S. Martinez, CMA (AAMA)

PROCEDURE 19-8 Performing Pulse Oximetry

Outcome Perform pulse oximetry.

Equipment/Supplies

- Handheld pulse oximeter
- Reusable finger probe
- Antiseptic wipe

1. **Procedural Step.** Sanitize your hands.
2. **Procedural Step.** Assemble the equipment. Handle the probe carefully, and perform the following:
   a. Carefully inspect the probe to ensure it opens and closes smoothly. Inspect the probe windows (LED and photodetector) to ensure they are clean and free of lint.
   b. Disinfect the probe windows and surrounding platforms with an antiseptic wipe, and allow them to dry.

Disinfect the probe with an antiseptic wipe. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

   c. If necessary, connect the probe to the cable.
   d. Connect the cable to the monitor by plugging it into the port on the monitor. Do not lift or carry the monitor by the cable.

Connect the cable to the monitor by plugging it into the port on the monitor. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Principle. Misuse or improper handling of the probe could damage it. Dirt or lint on the probe windows could interfere with proper light transmission, leading to an inaccurate reading. Cross-contamination among patients is prevented by disinfecting the probe. Lifting the monitor by the cable could damage the cable connections.

3. **Procedural Step.** Greet the patient and introduce yourself. Identify the patient and explain the procedure. Explain to the patient that the clip-on probe does not hurt and feels similar to a clothespin attached to the finger. If the patient seems fearful, place the probe on your own finger first to reassure the patient it is not painful.
4. **Procedural Step.** Seat the patient comfortably in a chair with the lower arm firmly supported and the palm facing down.
   Principle. Supporting the lower arm helps prevent patient movement during the procedure.
5. **Procedural Step.** Select an appropriate finger to apply the probe. Use the tip of the patient's index, middle, or ring finger. If the patient's fingers are very small or very large, and the probe cannot seem to be aligned properly, use the earlobe to take the measurement. If the patient exhibits tremors of the hands, use the earlobe to obtain the reading.
   Principle. The probe must be applied to a peripheral site with thin skin that is highly vascular. Very small or very large fingers may not allow for proper positioning of the probe on the finger.
6. **Procedural Step.** Observe the patient's fingernail. If the patient is wearing dark fingernail polish, ask her to remove it with acetone or nail polish remover. If the patient is wearing artificial nails, choose another probe site, such as the toe or earlobe.
   Principle. An opaque coating on the fingernail may interfere with proper light transmission through the finger, leading to an inaccurate reading.
7. **Procedural Step.** Check to ensure the patient's fingertip is clean. If it is dirty, cleanse the site with soap and water and allow it to dry. Ensure that the patient's finger is not cold. If it is cold, ask the patient to rub his or her hands together.
   Principle. Oils, dirt, or grime on the finger can interfere with the proper light transmission through the finger, leading to an inaccurate reading. Sometimes patients with cold fingers may have enough constriction of the capillaries that it interferes with obtaining a reading.
8. **Procedural Step.** Ensure that ambient light does not interfere with the measurement. Position the probe securely on the fingertip as follows:
   a. Ensure that the probe window is fully covered by placing the finger over the LED window with the fleshy tip of the finger covering the window. The tip of the finger should touch the end of the probe stop.

Continued

PROCEDURE 19-8

PROCEDURE 19-8 Performing Pulse Oximetry—cont'd

8a

Position the probe securely on the fingertip. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

b. Ensure that the LED and the photodetector are aligned opposite to each other.
c. Allow the cable to lie across the back of the hand and parallel to the arm of the patient.

Principle. Ambient light can be picked up by the probe and alter the reading. Proper alignment of the LED and photodetector is necessary for an accurate reading.

9. **Procedural Step.** Instruct the patient to remain still and to breathe normally. Turn on the oximeter by pressing the on/off control. Wait while the oximeter goes through its power-on self-test (POST). If the monitor fails the POST, refer to the troubleshooting section of the user manual for interpretation of the error code and necessary action that should be taken.

Principle. Patient movement may lead to an inaccurate reading. The monitor automatically conducts a POST to ensure it is functioning properly.

10. **Procedural Step.** Allow several seconds for the pulse oximeter to detect the pulse and calculate the oxygen saturation of the blood. Ensure that the pulse strength indicator fluctuates with each pulsation and that the pulse signal is strong. If the oximeter sounds an alarm indicating it was unable to locate a pulse, reposition the probe on the patient's finger or move the probe to another finger and perform the procedure again.

Principle. The reading takes several seconds to display. The pulse strength indicator provides a quick assessment of pulse quality. If the oximeter is unable to locate a pulse, it will be unable to obtain a reading.

11. **Procedural Step.** Leave the probe in place until the oximeter displays a reading. Read the oxygen saturation value and pulse rate, and make a mental note of these readings. On this pulse oximeter, the oxygen saturation reading is 99% and the pulse rate is 69. If the SpO_2 reading is less than 95%, reposition the probe on the finger and perform the procedure again.

10

Allow several seconds for the pulse oximeter to detect the pulse. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

11

Read the oxygen saturation value and pulse rate. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Principle. A low SpO_2 reading may be caused by improper positioning of the probe on the finger.

12. **Procedural Step.** Remove the probe from the patient's finger, and turn off the oximeter.
13. **Procedural Step.** Sanitize your hands, and chart the results. Include the date, time, SpO_2 reading, and pulse rate.
14. **Procedural Step.** Disconnect the cable from the monitor. Disinfect the probe with an antiseptic wipe. Properly store the monitor in a clean, dry area.

CHARTING EXAMPLE

Date	
10/15/10	2:30 p.m. SpO_2: 99%. P: 69.
	S. Martinez, RMA

BLOOD PRESSURE

Mechanism of Blood Pressure

Blood pressure (BP) is a measurement of the pressure or force exerted by the blood on the walls of the arteries in which it is contained. Each time the ventricles contract, blood is pushed out of the heart and into the aorta and pulmonary aorta, exerting pressure on the walls of the arteries. This phase in the cardiac cycle is known as **systole,** and it represents the highest point of blood pressure in the body, or the **systolic pressure.** The phase of the cardiac cycle in which the heart relaxes between contractions is referred to as **diastole.** The **diastolic pressure** (recorded during diastole) is lower because the heart is relaxed. Contraction and relaxation of the heart result in two different pressures, systolic and diastolic.

Interpretation of Blood Pressure

Blood pressure measurement is expressed as a fraction. The numerator is the systolic pressure, and the denominator is the diastolic pressure. The standard unit for measuring blood pressure is millimeters of mercury (mm Hg). A blood pressure reading of 110/70 mm Hg means that there was enough force to raise a column of mercury 110 mm during systole and 70 mm during diastole.

Based on guidelines from the National Heart, Lung, and Blood Institute (NHLBI), a blood pressure less than 120/80 mm Hg is classified as normal, whereas a blood pressure reading of 120/80 is classified as *prehypertension.* These guidelines were issued as a result of scientific studies showing that the risk of heart disease begins at a blood pressure reading lower than previously thought. The NHLBI guidelines are outlined in Table 19-7.

Blood pressure should be taken during every office visit to allow the physician to compare the patient's readings over time. This is a good preventive measure in guarding against serious illness. A single blood pressure reading taken on one occasion does not characterize an individual's blood pressure accurately. Several readings, taken on different occasions, provide a good index of an individual's baseline blood pressure.

Blood pressure readings should always be interpreted using a patient's baseline blood pressure. An increase or decrease of 20 to 30 mm Hg in a patient's baseline blood pressure is significant, even if it is still within the normal accepted blood pressure range.

The most common condition that causes an abnormal blood pressure reading is **hypertension.** Hypertension, or high blood pressure, results from excessive pressure on the walls of the arteries. Hypertension is determined by a sustained systolic blood pressure reading of 140 mm Hg or greater or a sustained diastolic reading of 90 mm Hg or greater. See Table 19-7 for the NHLBI classifications for hypertension. **Hypotension,** or low blood pressure, results from reduced pressure on the arterial walls. Hypotension is determined by a blood pressure reading less than 95/60 mm Hg.

Table 19-7 Classification of Blood Pressure for Adults Age 18 and Older

Blood Pressure Classifications	Systolic Blood Pressure (mm Hg)		Diastolic Blood Pressure (mm Hg)
Normal	Less than 120	*and*	Less than 80
Prehypertension*	120-139	*or*	80-89
Hypertension*			
Stage 1	140-159	*or*	90-99
Stage 2	160 or higher	*or*	100 or higher

From National Heart, Lung, and Blood Institute: *The seventh report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure, NIH Publication No. 03-5231,* Bethesda, Md, 2003, U.S. Department of Health and Human Services.

*Based on the average of two or more properly measured, seated blood pressure readings taken at each of two or more visits.

Pulse Pressure

The difference between systolic and diastolic pressure is the **pulse pressure.** It is determined by subtracting the smaller number from the larger. If the blood pressure is 110/70 mm Hg, the pulse pressure would be 40 mm Hg. A pulse pressure between 30 and 50 mm Hg is considered to be within normal range.

Factors Affecting Blood Pressure

Blood pressure does not remain at a constant value. Numerous factors may affect it throughout the course of the day. An understanding of these factors helps to ensure an accurate interpretation of blood pressure readings.

1. **Age.** Age is an important consideration when determining whether a patient's blood pressure is normal. As age increases, the blood pressure gradually increases: A 6-year-old child may have a normal reading of 90/60 mm Hg, whereas a young, healthy adult may have a blood pressure reading of 116/76 mm Hg, and it would not be unusual for a 60-year-old man to have a reading of 130/90 mm Hg. As an individual gets older, there is a loss of elasticity in the walls of the blood vessels, causing this increase in pressure to occur. Table 19-8 is a chart of the average optimal blood pressure readings for various age groups.
2. **Gender.** After puberty, women usually have a lower blood pressure than men of the same age. After menopause, women usually have a higher blood pressure than men of the same age.
3. **Diurnal variations.** Fluctuations in an individual's blood pressure are normal during the course of a day. When one awakens, the blood pressure is lower as a result of the decreased metabolism and physical activity during sleep. As metabolism and activity increase during the day, the blood pressure rises.
4. **Emotional states.** Strong emotional states, such as anger, fear, and excitement, increase the blood pressure. If the medical assistant observes such a reaction, an attempt

Table 19-8 Average Optimal Blood Pressure for Age

Age	Blood Pressure (mm Hg)
Newborn (6.6 lb)	40 (mean)
1 mo	85/54
1 yr	95/65
6 yr*	105/65
10-13 yr*	110/65
14-17 yr*	120/75
Adult	Less than 120/80

From National High Blood Pressure Education Program (NHBPEP); National Heart, Lung, and Blood Institute; National Institutes of Health: The seventh report of the Joint National Committees on Detection, Evaluation, and Treatment of High Blood Pressure, *JAMA* 239:2560, 2003.
*In children and adolescents, hypertension is defined as blood pressure that is, on repeated measurement, at the 95th percentile or greater adjusted for age, height, and gender (NHBPEP, 1997).

should be made to calm the patient before taking blood pressure.

5. **Exercise.** Physical activity temporarily increases the blood pressure. To ensure an accurate reading, a patient who has been involved in physical activity should be given an opportunity to rest for 20 to 30 minutes before blood pressure is measured.
6. **Body position.** The blood pressure of a patient who is in a lying or standing position is usually different from that measured when the patient is sitting. A notation should be made on the patient's chart if the reading was obtained in any position other than sitting, using the following abbreviations: *L* (lying) and *St* (standing).
7. **Medications.** Many medications may increase or decrease the blood pressure. Because of this factor, it is important to record in the patient chart all prescription and over-the-counter medications that the patient is taking.
8. **Other factors.** Other factors that may increase the blood pressure include pain, a recent meal, smoking, and bladder distention.

Assessment of Blood Pressure

The equipment needed to measure blood pressure includes a stethoscope and a sphygmomanometer. The **stethoscope** amplifies sounds produced by the body and allows the medical assistant to hear them.

Stethoscope

The most common type of stethoscope used in the medical office is the acoustic stethoscope. It consists of four parts: earpieces, sidepieces known as *binaurals,* plastic or rubber tubing, and a chest piece (Figure 19-19A).

Stethoscope Chest Piece

Two types of chest pieces exist: a *diaphragm,* which is a large, flat disc, and a bell, which has a bowl-shaped appearance (Figure 19-19B). The chest piece of a stethoscope consists of a diaphragm and a bell, or just a diaphragm. If a chest piece consists of a diaphragm and a bell, the medical assistant must ensure the desired piece is rotated into position before use. Failure to do so would not allow the medical assistant to hear sound through the earpieces.

What Would You Do? What Would You *Not* Do?

Case Study 3

Tyrone Jackson, 45 years old, is at the office to have his blood pressure checked. Three months ago, Tyrone started taking a diuretic and an antihypertensive prescribed by the physician to reduce his blood pressure. The last recording in his chart indicates that Tyrone's blood pressure decreased from 180/112 mm Hg to 126/84 mm Hg; however, his blood pressure at this visit is 158/98 mm Hg. Tyrone says that he has not been very good at taking his medication lately. He says it is really hard to remember to take all those pills every day. He also says that he felt just fine before being put on blood pressure pills, but when he started taking them, he felt awful. He had to urinate more often; when he got up fast, he felt dizzy; and he had some problems with headaches. Tyrone says that he decided to cut back on his pills to see if these problems got better, and sure enough, they went away altogether. Tyrone wants to know if there is anything he can do to lower his blood pressure other than taking pills. ■

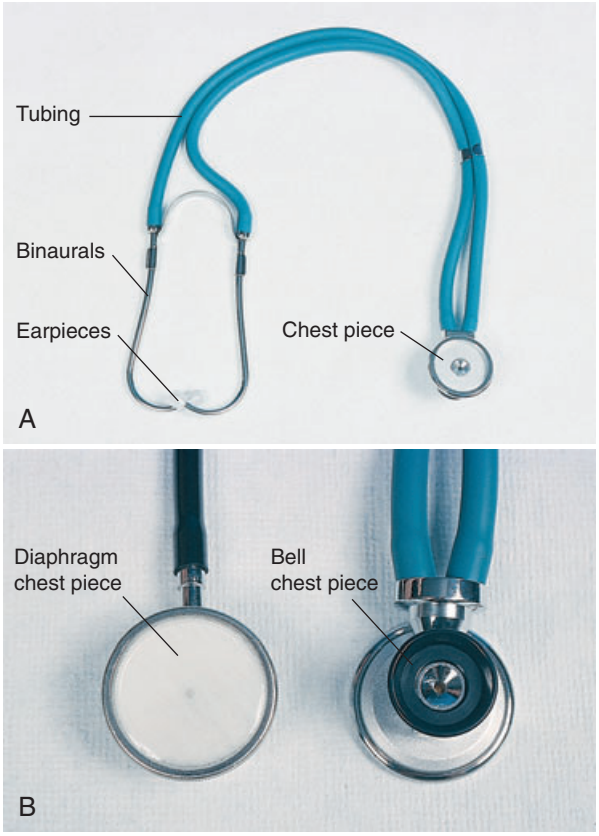


Figure 19-19. A, Parts of a stethoscope. **B,** Types of chest pieces. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

PATIENT TEACHING Hypertension

Answer questions patients have about hypertension.

What is high blood pressure?

Blood pressure is the force of blood against the walls of the arteries. High blood pressure, also called **hypertension,** means the pressure in the arteries is consistently above normal (140/90 mm Hg), resulting in excessive pressure on the walls of the arteries. Hypertension is the most common life-threatening disease among Americans. An estimated one in four Americans has high blood pressure. The incidence of hypertension in the United States has increased dramatically as a result of an aging population and increased incidence of obesity.

What are the symptoms of high blood pressure?

Approximately one third of people who have high blood pressure are unaware of it because there are few or no symptoms and, as a result, an individual with hypertension may go undiagnosed for many years. If symptoms do occur, they may include one or more of the following: headaches, dizziness, flushed face, fatigue, epistaxis (nosebleed), excessive perspiration, heart palpitations, frequent urination, and leg claudication (cramping in the legs with walking). The only way to know for sure whether you have high blood pressure is to have it checked regularly.

What causes high blood pressure?

In about 90% of cases, the precise cause of high blood pressure is unknown. This type of hypertension is known as *essential* or *primary hypertension.* Certain factors seem to increase the risk of developing essential hypertension, however, including:

- **Heredity.** A family history of high blood pressure increases an individual's risk of developing high blood pressure.
- **Weight.** Individuals who are overweight or obese are two to six times more likely than the general population to develop high blood pressure.
- **Ethnicity.** Research has shown that more black than white Americans develop high blood pressure.
- **Age.** Blood pressure normally increases as one grows older.
- **Sodium intake.** Sodium, found in salt and processed, canned, and most snack foods, does not cause high blood pressure; however, it can aggravate high blood pressure. Most Americans consume more sodium than they need. The current recommendation is to consume less than 2.4 g (2400 mg) of sodium per day. This is equivalent to 6 g (about 1 teaspoon) of salt.
- **Chronic stress.** Research indicates that people who are under continuous stress tend to develop more heart and circulatory problems than people who are not under stress.
- **Smoking.** Smoking tobacco constricts blood vessels, causing an increase in blood pressure.
- **Alcohol consumption.** Heavy alcohol consumption may increase the blood pressure.

The remaining 10% of individuals with hypertension have *secondary hypertension.* This means that the high blood pressure can be linked to a known cause, which includes chronic kidney disease, adrenal and thyroid disease, narrowing of the aorta, steroid therapy, oral contraceptives, and preeclampsia associated with pregnancy.

What can happen if high blood pressure is not treated?

If high blood pressure is not brought under control, it can cause severe damage to vital organs, such as the heart, brain, kidneys, and eyes. This damage can result in a heart attack or heart failure, stroke, kidney damage, or damaged vision. Early detection and treatment of high blood pressure can prevent these complications. High blood pressure is often discovered during a routine medical examination or (less commonly) when an individual experiences one of the complications of hypertension caused by damage to a vital organ.

Can high blood pressure be cured?

Essential hypertension cannot be cured, but many treatments are used to bring it under control. These include lifestyle modifications, such as weight reduction, a healthy diet rich in fruits and vegetables and low in saturated fat, limitation of salt intake, regular aerobic exercise, cessation of smoking, limitation or elimination of alcohol consumption, and stress management. If lifestyle modifications alone are not enough, medications are available for reducing blood pressure, allowing the patient to lead a normal, healthy, active life.

How long will I undergo treatment?

Treatment for essential hypertension is usually lifelong. Even if you feel fine, you will probably have to continue treatment for the rest of your life to maintain your blood pressure in a healthy range. If you discontinue your diet and lifestyle changes or stop taking your medication, your blood pressure will increase again.

- Encourage patients with hypertension to adhere to the treatment prescribed by the physician. Help patients remember to take their medication by telling them to associate their medication schedule with a daily routine, such as brushing their teeth or having meals.
- Provide the patient with educational materials on high blood pressure available from sources such as the American Heart Association. ■

The diaphragm chest piece is more useful for hearing high-pitched sounds, such as lung and bowel sounds, whereas the bell chest piece is more useful for hearing low-pitched sounds, such as those produced by the heart and vascular system. Before using a stethoscope, the medical assistant should ensure that it is in proper working condition.

Sphygmomanometers

The **sphygmomanometer** is an instrument that measures the pressure of blood within an artery. It consists of a **manometer,** an inner inflatable bladder surrounded by a covering known as the *cuff,* and a pressure bulb with a control valve to inflate and deflate the inner bladder. The

Highlight on Stethoscopes

The stethoscope was first introduced in the 1800s by a French physician named René Laënnec. This early stethoscope consisted of a simple wooden tube with a bell-shaped opening at one end.

The selection of a stethoscope is an individual decision. One hears sounds differently when using different stethoscopes. The primary consideration in choosing a stethoscope should be that it is well made and fits well in your ears. Stethoscopes are available from uniform shops and medical supply companies.

The usual length of tubing on a stethoscope is 12 to 16 inches (30 to 40 cm), but you may prefer the longer 22-inch tubing. An argument against long tubing is that it transmits sound less efficiently. Research has shown, however, that 6 to 8 more inches of tubing does not significantly alter the transmission of most sounds.

The stethoscope should have metal binaurals. The binaurals should allow you to angle the earpieces firmly to follow the direction of your ear canal. Binaurals that are too tight are uncomfortable, and binaurals that are too loose do not allow you to hear as well as you should.

The earpieces should fit comfortably and snugly in the ear canal. If you can understand what someone is saying in the same room, they are too loose, which would interfere with effective auscultation. Some stethoscopes come with removable ear tips in different sizes. This offers the advantage of selecting an ear tip that fits your ear canal. Flexible ear tips of soft rubber are usually more comfortable than nonflexible tips of hard rubber or plastic.

The chest piece should be a key factor in the selection of a stethoscope. A stethoscope with a diaphragm and a bell offers the most versatility for listening to different types of sounds. Many stethoscopes have a rubber or plastic rim around the diaphragm and bell to avoid chilling the patient with a cold chest piece and to decrease air leaks between the chest piece and the patient.

The most common problem with use of stethoscopes is air leaking. Air leaks interfere with effective sound transmission and allow environmental noise to enter the stethoscope. Air leaks may result from a cracked earpiece, a cracked or chipped chest piece, or a break in the tubing.

Stethoscopes must be cared for properly to ensure proper functioning and to prevent the transmission of disease in the medical office. The earpieces should be removed and cleaned regularly with a cotton-tipped applicator moistened with alcohol to remove cerumen. The chest piece should be cleaned with an antiseptic wipe to remove dirt, dust, lint, and oils. The tubing should be cleaned with a paper towel using an antimicrobial soap and water. Alcohol should not be used to clean the tubing because it can dry out the tubing and cause it to crack over time. ■

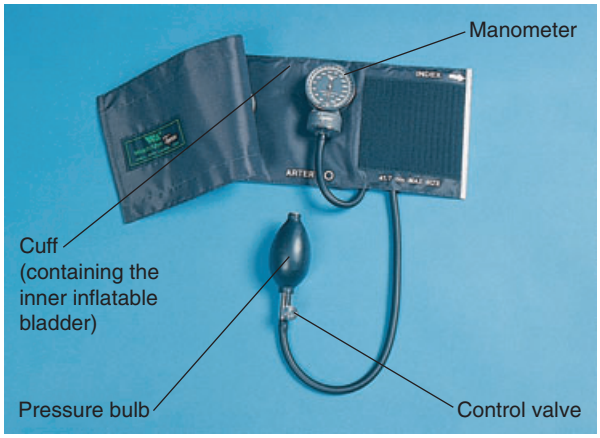


Figure 19-20. The parts of an aneroid sphygmomanometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Figure 19-21. The scale of the gauge of an aneroid sphygmomanometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

manometer contains a scale for registering the pressure of the air in the bladder.

The two types of sphygmomanometers are the aneroid and mercury. The *aneroid sphygmomanometer* is lightweight and portable, but the *mercury sphygmomanometer* is more accurate.

Aneroid Sphygmomanometer

The aneroid sphygmomanometer (Figure 19-20) has a manometer gauge with a round scale. The scale is calibrated in millimeters, with a needle that points to the calibrations (Figure 19-21). To ensure an accurate reading, the needle

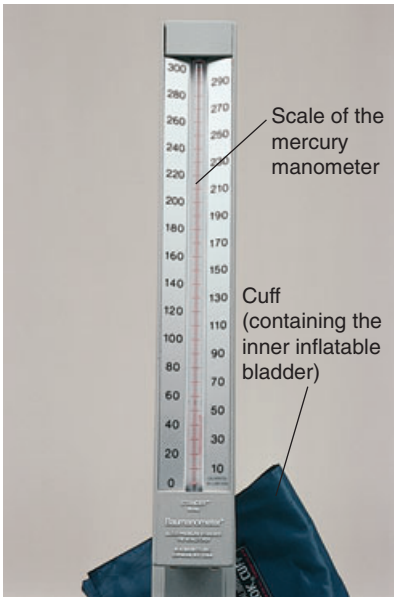


Figure 19-22. The parts of a mercury sphygmomanometer. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

must be positioned initially at zero. The manometer must be placed in the correct position for proper viewing. The medical assistant should be no farther than 3 feet from the scale on the gauge of the manometer, and the manometer should be placed so that it can be viewed directly. At least once a year, an aneroid sphygmomanometer should be recalibrated to ensure its accuracy.

Mercury Sphygmomanometer

The mercury sphygmomanometer (Figure 19-22) has a vertical tube calibrated in millimeters that is filled with mercury. Although more accurate than the aneroid sphygmomanometer, the use of the mercury sphygmomanometer is being discouraged because mercury is a hazardous chemical.

If a mercury manometer is used to measure blood pressure, it must be placed in the correct position for proper viewing. The medical assistant should be no farther than 3 feet from the scale of the manometer. A portable mercury manometer should be placed on a flat surface so that the mercury column is in a vertical position. The wall model mercury manometer is mounted securely against a wall, placing the mercury column in a vertical position.

The following guidelines must be followed when measuring blood pressure with a mercury sphygmomanometer. Before the blood pressure reading is obtained, the mercury must be even with the zero level at the base of the calibrated tube. Pressure created by inflation of the inner bladder causes the mercury to rise in the tube. The top portion of the mercury column, the **meniscus,** curves slightly upward. The blood pressure should be read at the top of the meniscus, with the eye at the same level as the meniscus of the mercury column.

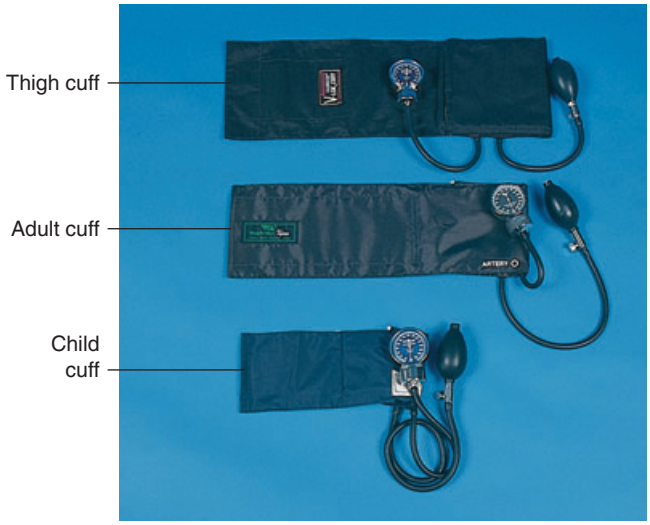


Figure 19-23. Blood pressure cuffs: child, adult, and thigh. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Table 19-9 Types of Blood Pressure Cuffs

Cuff	Bladder Length (cm)	Bladder Width (cm)	Acceptable Circumference (cm)
Child arm	21	8	16-21
Small adult arm	24	10	22-26
Adult arm	30	13	27-34
Large adult arm	38	16	35-44
Adult thigh	42	20	45-52

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.

Cuff Sizes

Blood pressure cuffs come in a variety of sizes and are measured in centimeters (cm) (Figure 19-23). The size of a cuff refers to its inner inflatable bladder, rather than its cloth cover. Table 19-9 lists the types of cuffs available and the size of the inner bladder of each cuff.

For accurate blood pressure measurement, the inner bladder of the cuff should encircle at least 80% of the arm circumference and be wide enough to cover two thirds of the distance from the axilla to the antecubital space (Figure 19-24). Child cuffs often must be used for adults with thin arms. The adult cuff is used for the average-sized adult arm, and the thigh cuff is used for taking blood pressure from the thigh or for adults with large arms. If the cuff is too small, the reading may be falsely high, as it would be, for example, when an adult cuff is used on a patient with a large arm. If the cuff is too large, the reading may be falsely low, as it would be when an adult cuff is used with a patient with a thin arm. The cuff should fit snugly and should be applied so that the center of the inflatable bag is directly over the brachial artery to allow for complete compression of the artery. The cuff has an interlocking, self-sticking

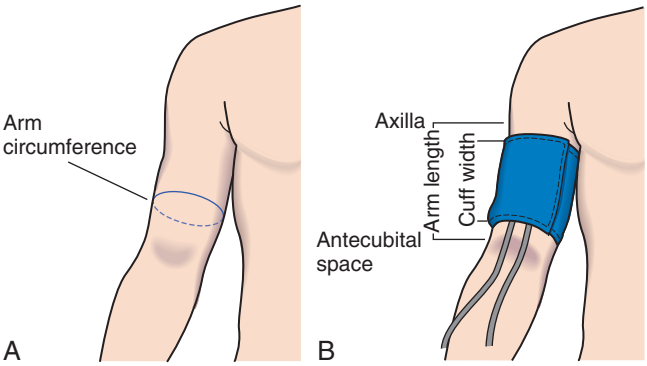


Figure 19-24. Determination of proper cuff size. **A,** The bladder of the cuff should be long enough to encircle 80% of the arm. **B,** The cuff should be wide enough to cover two thirds of the distance from the axilla to the antecubital space. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

substance (Velcro) that facilitates closing and fastening the cuff in place temporarily.

Korotkoff Sounds

Korotkoff sounds are used to determine the systolic and diastolic blood pressure readings. When the bladder of the cuff is inflated, the brachial artery is compressed so that no audible sounds are heard through the stethoscope. As the cuff is deflated, at a rate of 2 to 3 mm Hg per second, the sounds become audible until the blood flows freely and they can no longer be heard (Table 19-10). The medical assistant should practice listening to these sounds and be able to identify the various phases.

Procedure 19-9 outlines the procedure for taking blood pressure using an aneroid sphygmomanometer. Procedure 19-10 outlines the procedure for determining systolic pressure by palpation.

Table 19-10 Korotkoff Sounds

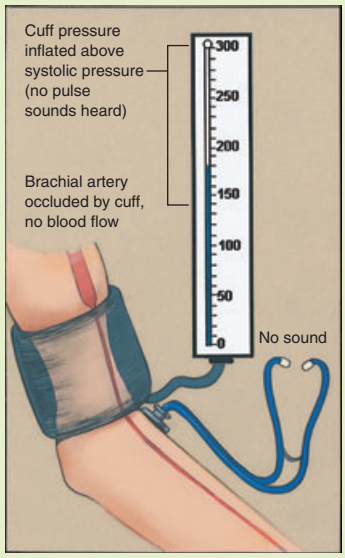
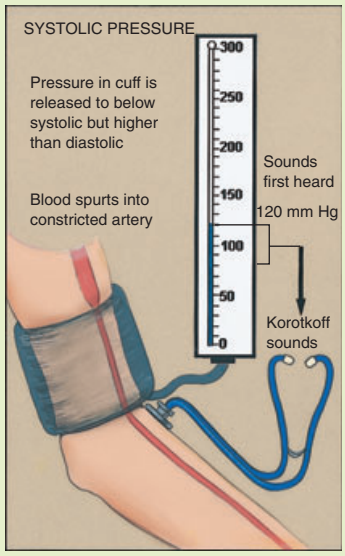
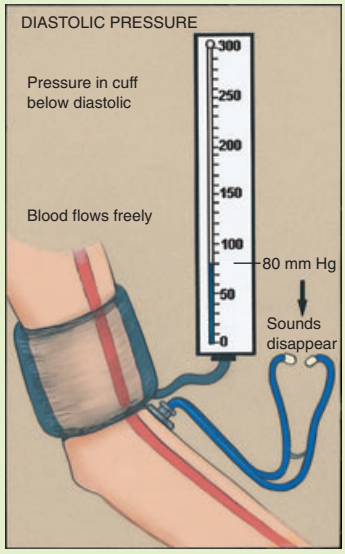
Phase	Description	Illustration
	Inflation of cuff compresses and closes off brachial artery so that no blood flows through artery	 Cuff pressure inflated above systolic pressure (no pulse sounds heard) Brachial artery occluded by cuff, no blood flow 300 250 200 150 100 50 0 No sound
Phase I	First faint but clear tapping sound is heard, and it gradually increases in intensity. First tapping sound is systolic pressure	 SYSTOLIC PRESSURE Pressure in cuff is released to below systolic but higher than diastolic Blood spurts into constricted artery 300 250 200 150 100 50 0 Sounds first heard 120 mm Hg Korotkoff sounds

Table 19-10 Korotkoff Sounds—cont'd

Phase	Description	Illustration
Phase II	As cuff continues to deflate, sounds have murmuring or swishing quality	
Phase III	With further deflation, sounds become crisper and increase in intensity	
Phase IV	Sounds become muffled and have soft, blowing quality. According to the American Heart Association, onset of muffled sounds is best index of diastolic pressure in children Pressure in cuff is released at moderate steady rate of 2-3 mm Hg per second	
Phase V	Sounds disappear. This is typically recorded as diastolic pressure for an adult. Some authorities believe that adult diastolic pressure falls midway between phases IV and V; some physicians want the medical assistant to record phases IV and V as the diastolic pressure (e.g., 120/84/80)	

From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.

Prevention of Errors in Blood Pressure Measurement

The following guidelines should be followed to prevent errors in blood pressure measurement:

1. **Instruct the patient** not to consume caffeine or use tobacco for 30 minutes before blood pressure measurement.
2. **The patient should be seated** in a quiet room for at least 5 minutes before blood pressure is taken. Patient anxiety and apprehension can cause a spasm of the brachial artery, which can increase the blood pressure reading by as much as 30 to 50 mm/Hg. This is known as the "white coat effect," which refers to the white laboratory coat worn by the physician.
3. **Always use the proper cuff size.** If the cuff is too small, it may come loose as the cuff is inflated, or the reading may be falsely high. If the cuff is too large, the reading may be falsely low. The inner inflatable bladder of the cuff should encircle at least 80% of the patient's arm and cover two thirds of the distance from the axilla to the antecubital space.
4. **Never take blood pressure over clothing.** Clothing interferes with the ability to hear the Korotkoff sounds, which could result in an inaccurate blood pressure reading. Roll up the patient's sleeve approximately 5 inches above the elbow. If the sleeve is too tight after being rolled up, remove the arm from the sleeve. A tight sleeve causes partial compression of the brachial artery, resulting in an inaccurate reading.
5. **Position the patient's arm properly.** Position the arm at heart level, and ensure it is well supported with the palm facing upward. If the arm is above heart level, the blood pressure reading may be falsely low. If the arm is not supported or placed below heart level, the blood pressure reading may be falsely high.
6. **Avoid extraneous sounds from the cuff.** Position the cuff approximately 1 to 2 inches above the bend in the elbow. The cuff should be up far enough to prevent the stethoscope from touching it; otherwise, extraneous sounds, which could interfere with an accurate measurement, may be picked up.
7. **Compress the brachial artery completely.** Center the inner bladder of the cuff directly over the artery to be compressed. Most cuffs are labeled with arrows indicating the center of the bladder for the right and left arms. Centering the inner bladder allows for complete compression of the brachial artery.
8. **Apply equal pressure over the brachial artery.** The cuff should be applied so that it fits smoothly and snugly around the patient's arm. This prevents bulging or slipping and permits application of an equal pressure over the brachial artery. A loose-fitting cuff can cause a falsely high reading.
9. **Position the earpieces so that you can hear the sounds clearly.** Place the earpieces of the stethoscope in your ears with the earpieces directed slightly forward. This allows the earpieces to follow the direction of the ear canal, which facilitates hearing.
10. **Avoid extraneous sounds from the tubing.** Make sure the tubing of the stethoscope hangs freely and is not permitted to rub against any object. If the stethoscope tubing rubs against an object, extraneous sounds may be picked up, which could interfere with an accurate measurement.
11. **Position the chest piece properly.** Palpate the brachial pulse to provide good positioning of the chest piece over the brachial artery. Place the chest piece firmly, but gently, over the brachial artery to assist in transmitting clear and audible sounds. Do not allow the chest piece to touch the cuff to prevent extraneous sounds from being picked up, which could interfere with an accurate measurement.
12. **Release the pressure at a moderate steady rate.** Release the pressure in the cuff at a rate of 2 to 3 mm Hg/sec to ensure an accurate blood pressure measurement. Releasing the pressure too slowly is uncomfortable for the patient and could cause a falsely high diastolic reading. Releasing the pressure too quickly could cause a falsely low systolic reading.

Continued

Prevention of Errors in Blood Pressure Measurement—cont'd

13. **Avoid venous congestion.** If you need to take the blood pressure in the same arm again, wait 1 to 2 minutes to allow blood trapped in the veins (venous congestion) to be released. Venous congestion can result in a falsely high systolic reading and a falsely low diastolic reading.
14. **Measure and record the blood pressure in both arms during the initial blood pressure assessment of a new patient.** There may normally be a difference of 5 to 10 mm Hg between the two arms. During return visits, the blood pressure should be measured in the arm with the higher initial reading.

PROCEDURE 19-9 Measuring Blood Pressure

Outcome Measure blood pressure.

Equipment/Supplies

- Stethoscope
- Sphygmomanometer
- Antiseptic wipe

1. Procedural Step. Sanitize your hands, and assemble the equipment. If the chest piece consists of a diaphragm and a bell, rotate it to the diaphragm position. Clean the earpieces and chest piece of the stethoscope with the antiseptic wipe.
Principle. The chest piece must be rotated to the proper position for sound to be heard through the earpieces.

Rotate the chest piece to the diaphragm position. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

2. Procedural Step. Greet the patient and introduce yourself. Identify the patient and explain the procedure. Explain to the patient that measuring blood pressure may normally cause a little numbing and tingling in the arm when the cuff is inflated. While explaining the procedure, observe the patient for signs that might influence the reading, such as anger, fear, pain, and recent physical activity. If it is not possible to reduce or eliminate these influences, list them in the patient's chart. Determine how high to pump the cuff by checking the patient's chart for previously measured systolic reading, or determine the patient's systolic pressure by palpation (see Procedure 19-10).

3. Procedural Step. Have the patient sit quietly in a comfortable position for at least 5 minutes before measuring his or her blood pressure. Roll up the patient's sleeve approximately 5 inches above the elbow. If the sleeve does not roll up or is too tight after being rolled up, remove the arm from the sleeve. The arm should be positioned at heart level and well supported, with the palm facing up.
Principle. Patient anxiety can cause a significant increase in blood pressure. Clothing interferes with the ability to hear the Korotkoff sounds, which could result in an inaccurate blood pressure reading. A tight sleeve causes partial compression of the brachial artery, resulting in an inaccurate reading. The position of the arm allows easy access to the brachial artery. Placing the arm above heart level may cause the reading to be falsely low. Not supporting the arm or placing it below heart level may cause the reading to be falsely high.

4. Procedural Step. Select the proper cuff size. The inner inflatable bladder of the cuff should be long enough to encircle at least 80% of the patient's arm and wide enough to cover two thirds of the distance from the axilla to the antecubital space.
Principle. The appropriate size cuff must be used to ensure an accurate measurement. If the cuff is too small, it may come loose as the cuff is inflated or the reading may be falsely high. If the cuff is too large, the reading may be falsely low.

4

The inner bladder should encircle at least 80% of the patient's arm. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

5

Center the inner bladder over the brachial pulse site. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

5. **Procedural Step.** Locate the brachial pulse with the fingertips. The brachial pulse is located near the center of the antecubital space but slightly to the little finger side of the arm. Center the inner bladder over the brachial pulse site. (*Note:* Place the cuff on the patient's arm so that the lower edge of the cuff is approximately 1 to 2 inches above the bend in the elbow. Most cuffs are labeled with a right and left arrow indicating the center of the bladder. The right arrow should be placed over the brachial pulse site when you are using the right arm, and the left arrow should be placed over the brachial pulse site when you are using the left arm.)
Principle. The cuff should be placed high enough to prevent the stethoscope from touching it; otherwise, extraneous sounds, which could interfere with an accurate measurement, may be picked up. Centering the inner bladder over the pulse site allows complete compression of the brachial artery.
6. **Procedural Step.** Wrap the cuff smoothly and snugly around the patient's arm, and secure the end of it.
Principle. Applying the cuff properly prevents it from bulging or slipping. This technique permits application of an equal pressure over the brachial artery.
7. **Procedural Step.** Position the manometer for direct viewing and at a distance of no more than 3 feet.
Principle. The medical assistant may have trouble seeing the scale on the manometer if it is placed more than 3 feet away.
8. **Procedural Step.** Place the earpieces of the stethoscope in your ears, with the earpieces directed slightly forward. During the blood pressure measurement, the tubing of the stethoscope should hang freely and should not be permitted to rub against any object.
Principle. The earpieces should be directed forward, permitting them to follow the direction of the ear canal, which facilitates hearing. If the stethoscope tubing rubs against an object, extraneous sounds may be picked up, which would interfere with an accurate measurement.
9. **Procedural Step.** Making sure the arm is well extended, locate the brachial pulse again and place the diaphragm of the stethoscope over the brachial pulse site. The diaphragm should be positioned to make a tight seal against the patient's skin. Enough pressure should be exerted to leave a temporary ring on the patient's skin when the disk is removed. Do not allow the chest piece to touch the cuff.
Principle. A well-extended arm allows easier palpation of the brachial pulse. Locating the brachial pulse again is necessary for proper positioning of the chest piece over the brachial artery. Proper positioning of the diaphragm and good contact of the diaphragm with the skin helps transmit clear and audible Korotkoff sounds through the earpieces of the stethoscope. If the diaphragm touches the cuff, extraneous sounds may be picked up, which would interfere with an accurate measurement.

Continued

PROCEDURE 19-9 Measuring Blood Pressure—cont'd

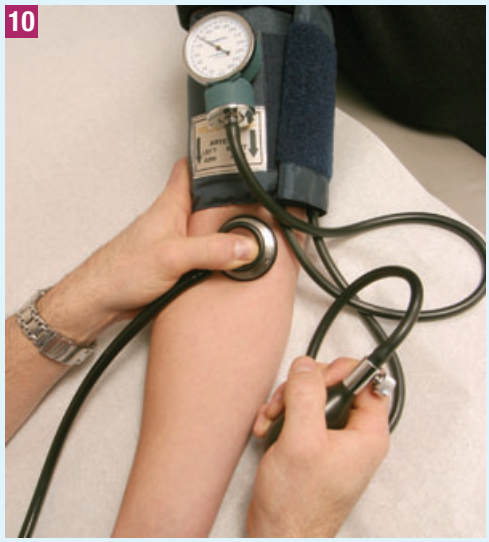
Locate the brachial pulse again before placing the diaphragm over the site. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

10. Procedural Step. Close the valve on the bulb by turning the thumbscrew clockwise (to the right) with the thumb and forefinger of your dominant hand until it feels tight but can still be loosened with the thumb and forefinger of one hand when you need to deflate the cuff. Pump air into the cuff as rapidly as possible to a level of 20 to 30 mm Hg above the previously measured or palpated systolic pressure.

Principle. Inflation of the cuff compresses and closes off the brachial artery so that no blood flows through the artery. If the patient has had the blood pressure measured previously at the medical office, the recorded systolic pressure can be used to determine how high to inflate the cuff. A preliminary determination of the systolic pressure by palpation allows the medical assistant to estimate how high to inflate the cuff.

11. Procedural Step. Release the pressure at a moderately steady rate of 2 to 3 mm Hg/sec by slowly turning the thumbscrew counterclockwise (to the left) with the thumb and forefinger. This opens the valve and allows the air in the cuff to escape slowly. Listen for the first clear tapping sound (phase I of the Korotkoff sounds). This represents the systolic pressure. Note this point on the scale of the manometer.

Principle. Releasing the pressure too slowly is uncomfortable for the patient and could cause a falsely high diastolic reading. Releasing the pressure too quickly could cause a falsely low systolic reading. The systolic pressure is the point at which the blood first begins to spurt through the artery as the cuff pressure begins to decrease; it represents the pressure that occurs on the walls of the arteries during systole.



Pump air into the cuff as rapidly as possible. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

Release the pressure at a moderately steady rate. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

12. **Procedural Step.** Continue to deflate the cuff while listening to the Korotkoff sounds. Listen for the onset of the muffled sound that occurs during phase IV. Continue to deflate the cuff, and note the point on the scale at which the sound ceases (phase V). Continue to steadily deflate the cuff for another 10 mm/Hg to ensure there are no more sounds.
Principle. Phase V marks the diastolic pressure (which represents the pressure that occurs on the walls of the arteries during diastole); the cuff pressure is reduced, and blood is flowing freely through the brachial artery.
13. **Procedural Step.** Quickly and completely deflate the cuff to zero. If you could not obtain an accurate blood pressure reading, wait 1 to 2 minutes before taking another measurement on the same arm. Remove the earpieces of the stethoscope from your ears, and carefully remove the cuff from the patient's arm.
Principle. Venous congestion results when blood pressure is taken, which alters a second reading if it is taken too soon on the same arm.
14. **Procedural Step.** Sanitize your hands, and chart the results. Include the date, time, and blood pressure reading. Blood pressure is recorded using even numbers. Make a notation in the patient's chart if the lying or standing position was used to take blood pressure. Abbreviations that can be used are *L* (lying) and *St* (standing).
15. **Procedural Step.** Clean the earpieces and the chest piece of the stethoscope with an antiseptic wipe, and replace the equipment properly.

CHARTING EXAMPLE

Date	
10/20/10	2:30 p.m. BP: 106/74.—S. Martinez, RMA

PROCEDURE 19-10

PROCEDURE 19-10 Determining Systolic Pressure by Palpation

Outcome Determine systolic pressure by palpation.

Equipment/Supplies

- Sphygmomanometer

1. **Procedural Step.** Sanitize your hands, and assemble the equipment.
2. **Procedural Step.** Locate the brachial pulse with the fingertips. Place the cuff on the patient's arm so that the inner bladder is centered over the brachial pulse site.
3. **Procedural Step.** Wrap the cuff smoothly and snugly around the patient's arm, and secure the end of it.
4. **Procedural Step.** Position the manometer for direct viewing and at a distance of no more than 3 feet.
5. **Procedural Step.** Locate the radial pulse with your fingertips.
6. **Procedural Step.** Close the valve on the bulb, and pump air into the cuff until the pulsation ceases.
7. **Procedural Step.** Release the valve at a moderate rate of 2 to 3 mm Hg per heartbeat while palpating the artery with your fingertips.
8. **Procedural Step.** Record the point at which the pulsation reappears as the palpated systolic pressure.
9. **Procedural Step.** Deflate the cuff completely, and wait 15 to 30 seconds before checking the blood pressure.

Release the valve while palpating the radial artery. (From Bonewit-West K: *Clinical procedures for medical assistants,* ed 7, St. Louis, 2008, Saunders.)

MEDICAL PRACTICE *and the* LAW

Measurement of vital signs is standard procedure for almost every patient in the physician's office. Because vital sign measurements are performed so frequently, the medical assistant may tend to minimize their importance. Changes in vital signs may be the first indicator of disease or illness, so meticulous attention must be paid to the performance and documentation of vital signs and to comparing the current measurements with past measurements for each patient.

Most patients want to know their vital signs, especially their blood pressure or temperature if febrile. Although the patient owns the information that you collect, be aware that you may not give this information to family members without the patient's consent. Some offices have a policy that indicates specific information the medical assistant can give the patient; some physicians prefer to disclose this information themselves and discuss it with their patients.

Often the measurement of vital signs is the first contact the patients have with the medical assistant. The most important factor in determining whether a patient will sue is not the skill of the practitioner, but the level of rapport with the patient. In everything you do, convey your caring and concern to every patient. ■

What Would You Do? What Would You *Not* Do? RESPONSES

Case Study 1

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What Did Sergio Do?

- ❑ Told Mrs. Mason that sometimes ear thermometers can be a little tricky to use.
- ❑ Showed Mrs. Mason how to use the ear thermometer and let her practice by taking Olivia's temperature.
- ❑ Explained how to care for and maintain the ear thermometer to prevent inaccurate readings.
- ❑ Explained to Mrs. Mason that the use of mercury is being discouraged because it can be toxic to humans and animals.

What Did Sergio* Not *Do?

- ❑ Did not ask Mrs. Mason if she had read the directions that came with her ear thermometer.
- ❑ Did not tell Mrs. Mason that she should switch back to the mercury thermometer.
- ❑ Did not ask Mrs. Mason why she waited so long to bring Olivia to the office.

What Would You Do/What Would You *Not* Do? Review Sergio's response and place a checkmark next to the information you included in your response. List the additional information you included in your response.

_____

_____

_____

_____

Case Study 2

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What Did Sergio Do?

- ❑ Recognized and congratulated Alex on his swimming achievements.
- ❑ Told Alex that it is normal for his pulse to be that slow because of his athletic training and it shows that he is in good shape.
- ❑ Assured Alex that the physician will do everything he can to help Alex.
- ❑ Stressed to Alex how important it is to follow the physician's advice so that his shoulder heals as soon as possible.

What Did Sergio* Not *Do?

- ❑ Did not comment on Alex's request for a steroid injection or OxyContin. Made sure to chart the information so that the physician could handle the situation.
- ❑ Did not criticize Alex for putting a swim meet before his health.

What Would You Do/What Would You *Not* Do? Review Sergio's response and place a checkmark next to the information you included in your response. List the additional information you included in your response.

_____

_____

_____

_____

Case Study 3

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What Did Sergio Do?

- ❑ Empathized with Tyrone about having to take so many pills. Suggested that he get a daily pill container to help him remember.
- ❑ Stressed to Tyrone the importance of taking his blood pressure medication. Explained to him that high blood pressure is a "silent disease." He may feel fine, but damage to his body organs can still be taking place if he does not take his pills.
- ❑ Gave Tyrone a brochure about high blood pressure and went over the long-term effects of hypertension and lifestyle changes that could help lower blood pressure.
- ❑ Encouraged Tyrone to call the office when he experiences side effects from medications because the physician may be able to do something to help.

What Would You Do? What Would You *Not* Do? RESPONSES—cont'd

What Did Sergio* Not *Do?

❑ Did not tell him it was all right to discontinue his medication.

What Would You Do/What Would You *Not* Do? Review Sergio's response and place a checkmark next to the information you included in your response. List the additional information you included in your response.

TERMINOLOGY REVIEW

Adventitious sounds Abnormal breath sounds.
Afebrile Without fever; the body temperature is normal.
Alveolus A thin-walled air sac of the lungs in which the exchange of oxygen and carbon dioxide takes place.
Antecubital space The space located at the front of the elbow.
Antipyretic An agent that reduces fever.
Aorta The major trunk of the arterial system of the body. The aorta arises from the upper surface of the left ventricle.
Apnea The temporary cessation of breathing.
Axilla The armpit.
Bounding pulse A pulse with an increased volume that feels strong and full.
Bradycardia An abnormally slow heart rate (less than 60 beats per minute).
Bradypnea An abnormal decrease in the respiratory rate of less than 10 respirations per minute.
Celsius scale A temperature scale on which the freezing point of water is 0° and the boiling point of water is 100°; also called the *centigrade scale.*
Conduction The transfer of energy, such as heat, from one object to another by direct contact.
Convection The transfer of energy, such as heat, through air currents.
Crisis A sudden falling of an elevated body temperature to normal.
Cyanosis A bluish discoloration of the skin and mucous membranes.
Diastole The phase in the cardiac cycle in which the heart relaxes between contractions.
Diastolic pressure The point of lesser pressure on the arterial wall, which is recorded during diastole.
Dyspnea Shortness of breath or difficulty in breathing.
Dysrhythmia An irregular rhythm; also termed *arrhythmia.*
Eupnea Normal respiration. The rate is 16 to 20 respirations per minute, the rhythm is even and regular, and the depth is normal.
Exhalation The act of breathing out.
Fahrenheit scale A temperature scale on which the freezing point of water is 32° and the boiling point of water is 212°.
Febrile Pertaining to fever.
Fever A body temperature that is above normal; synonym for *pyrexia.*
Frenulum linguae The midline fold that connects the undersurface of the tongue with the floor of the mouth.
Hyperpnea An abnormal increase in the rate and depth of respiration.
Hyperpyrexia An extremely high fever.
Hypertension High blood pressure.
Hyperventilation An abnormally fast and deep type of breathing, usually associated with acute anxiety conditions.
Hypopnea An abnormal decrease in the rate and depth of respiration.
Hypotension Low blood pressure.
Hypothermia A body temperature that is below normal.
Hypoxemia A decrease in the oxygen saturation of the blood. Hypoxemia may lead to hypoxia.
Hypoxia A reduction in the oxygen supply to the tissues of the body.
Inhalation The act of breathing in.
Intercostal Between the ribs.
Korotkoff sounds Sounds heard during the measurement of blood pressure that are used to determine the systolic and diastolic blood pressure readings.
Malaise A vague sense of body discomfort, weakness, and fatigue that often marks the onset of a disease and continues through the course of the illness.
Manometer An instrument for measuring pressure.
Meniscus The curved surface on a column of liquid in a tube.
Orthopnea The condition in which breathing is easier when an individual is in a sitting or standing position.

Continued

TERMINOLOGY REVIEW—cont'd

Pulse oximeter A computerized device consisting of a probe and monitor used to measure the oxygen saturation of arterial blood.
Pulse oximetry The use of a pulse oximeter to measure the oxygen saturation of arterial blood.
Pulse pressure The difference between the systolic and diastolic pressures.
Pulse rhythm The time interval between heartbeats.
Pulse volume The strength of the heartbeat.
Radiation The transfer of energy, such as heat, in the form of waves.
SaO_2 (saturation of arterial oxygen) Abbreviation for the percentage of hemoglobin that is saturated with oxygen in arterial blood.
Sphygmomanometer An instrument for measuring arterial blood pressure.
SpO_2 (saturation of peripheral oxygen) Abbreviation for the percentage of hemoglobin that is saturated with oxygen in arterial blood as measured by a pulse oximeter.
Stethoscope An instrument for amplifying and hearing sounds produced by the body.
Systole The phase in the cardiac cycle in which the ventricles contract, sending blood out of the heart and into the aorta and pulmonary aorta.
Systolic pressure The point of maximum pressure on the arterial walls, which is recorded during systole.
Tachycardia An abnormally fast heart rate (greater than 100 beats per minute).
Tachypnea An abnormal increase in the respiratory rate of more than 20 respirations per minute.
Thready pulse A pulse with a decreased volume that feels weak and thin.

ON THE WEB

For Information on Hypertension:

American Heart Association: www.americanheart.org

National Heart, Lung, and Blood Institute: www.nhlbi.nih.gov

Cardiology Channel: www.cardiologychannel.com

Hypertension Education Foundation: www.hypertension-foundation.org

American Society of Hypertension: www.ash-us.org

For Information on Lung Disease:

American Lung Association: www.lungusa.org

Pulmonology Channel: www.pulmonologychannel.com

Lung Cancer Online: www.lungcanceronline.org

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Visit the Evolve site at http://evolve.elsevier.com/Bonewit/today/ to actively Prepare for your Certification.

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